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# RADIOLOGY

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No. 1

## THE ROENTGEN-RAY DIAGNOSIS OF INFLAMMATORY DISEASE OF THE APPENDIX<sup>1</sup>

By JOSEPH C. BELL, M.D., LOUISVILLE, KENTUCKY

ALTHOUGH much has been written concerning the roentgen-ray diagnosis of disease of the appendix, in this paper no attempt is made to review this material, for the reports here are based only on independent, personal observation. I have no doubt that many others have based their diagnoses on similar criteria. Within the past month Moore and Merritt<sup>2</sup> have described some of the same findings. Carman, in his book, "The Roentgen Diagnosis of Diseases of the Alimentary Canal," placed special emphasis on an article by Spriggs and Marxer in *The Lancet* of 1919. This has undoubtedly formed the basis for much of the best work that has been done in roentgen diagnosis of disease of the appendix.

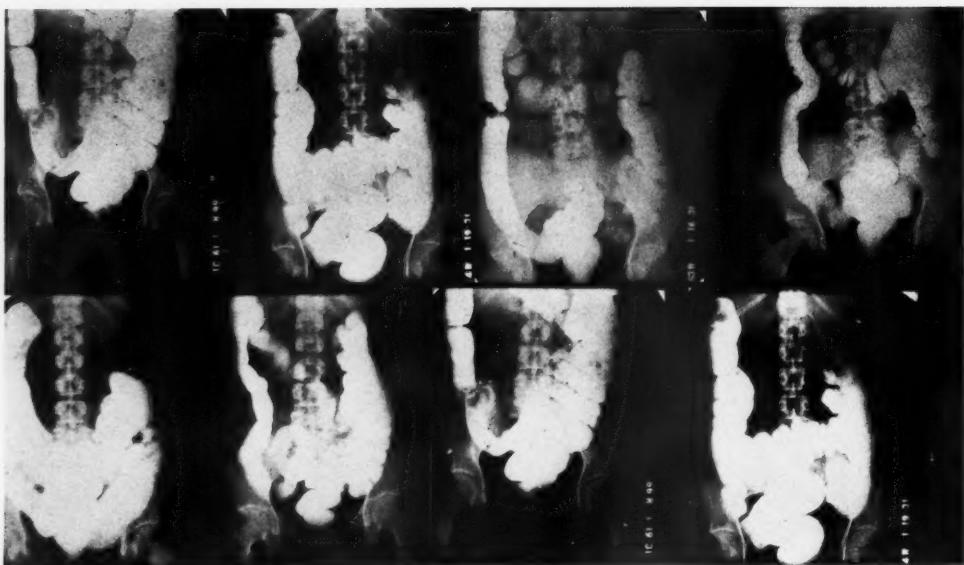
That all of the criteria advanced have been more or less unsatisfactory and unreliable is evident from the multiplicity of methods described, none of which has come into general use. Many surgeons of experience are hesitant to operate in cases in which a diagnosis of disease of the appendix has been made roentgenographically, evidently because previous experience

has shown that these findings are unreliable. These same surgeons know that the results of appendectomy in some cases of so-called chronic appendicitis are brilliant, but in a much larger group they are unsatisfactory. Because of this experience they recognize a real need for a type of examination that is dependable and will indicate with reasonable certainty the cases in which surgery is a consideration. I do not believe that this is true of any of the methods now in common use.

What are the indications for surgical intervention in disease of the appendix? In my opinion this must be answered from two viewpoints, the first being active inflammatory disease, and the second, mechanical disturbance resulting from previous inflammation in the appendix or other closely related structures. In active inflammation three grades are generally recognized, acute, subacute, and chronic. The characteristics of acute appendicitis are well known and do not require repetition. Spontaneous healing may take place or serious complications result. Subacute appendicitis may be a stage of subsiding acute appendix, which may later be followed by complete healing. On the other hand, there is evidence pointing to the fact that the stage of subacute inflammation may continue over a period of months or possibly years. The term "chron-

<sup>1</sup>Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

<sup>2</sup>Moore, A. B., and Merritt, E. A.: Roentgenologic Diagnosis of Appendicitis. *Jour. Am. Med. Assn.*, Nov. 14, 1931, XCVII, 1456, 1457.



Figs. 1, 2, 3, and 4. Colons in normal individuals after barium enema, without catharsis.

ic appendicitis," a loose one, generally covers any long-standing abnormality of the appendix due to active low grade infection or the result of previous infection. In the above classification it applies only to low grade, active inflammation. It may be a late stage in a subsiding acute appendicitis which will go on to complete repair, or it may continue as a low grade inflammatory condition for years.

The indications for surgical intervention in the acute cases are generally recognized. In subacute appendicitis they are not so clear, probably because accurate diagnosis is much less certain. Granting that the diagnosis is made, two courses are open: either to remove the appendix or leave it undisturbed. If an appendectomy is done, the possibility of future attacks is removed, as well as a probable source of focal infection. If it is left undisturbed, the infection may heal entirely or it may be followed by subsequent acute attacks. On the other hand, I believe that a low grade inflammation may persist for years and it is conceiv-

able that it may later cause disturbances in other organs. The possibility of some relationship between inflammatory disease of the appendix and peptic ulcer, gall-bladder disease, and colitis is one that has been considered from time to time but has never been generally accepted. Much the same can be said of the low grade, active inflammatory cases known generally as chronic appendicitis. However low grade the inflammation, if it can definitely be established as active, surgery is at least to be considered. An abscessed tooth need not be causing acute symptoms to justify removal.

In the second group, non-inflammatory cases, surgery is chiefly indicated when there is hindrance to the normal passage of material through the intestinal tract as a result of the condition present. Adhesions in themselves may possibly cause discomfort sufficient to warrant intervention, but this is rare.

This paper is concerned only with the diagnosis of active inflammatory disease of the appendix in each of the above stages.

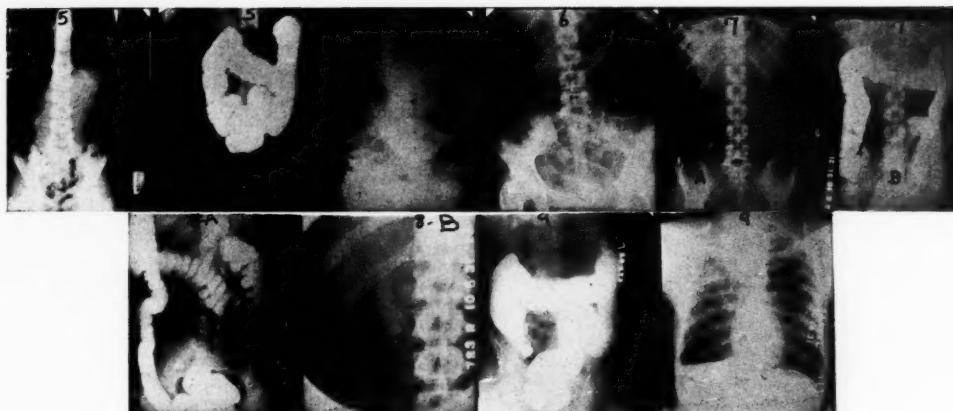


Fig. 5 (upper left). Foreign bodies, two birdshot, in appendix.

Fig. 6 (upper center). Obstruction of terminal ileum. Preliminary film shows dilated loops. The second film was made, after partial evacuation of a barium enema, with the patient upright. Fluid levels in small bowel characteristic of obstruction can be seen surrounded by the colon.

Fig. 7-A (upper right). Large calcified lymph nodes above right side of sacrum in a young individual. There are also calcium deposits in the spleen which cannot be well shown.

Fig. 7-B (upper right). Appearance after barium enema, showing relationship of lymph nodes to the cecum.

Fig. 8-A (lower left). Undescended cecum demonstrated by barium enema.

Fig. 8-B (lower left). Cholecystogram in same case with shadow of air-filled appendix lying slightly lateral to the gall bladder.

Fig. 9 (lower right). Tuberculosis of cecum, and film of chest in the same case.

It is based on careful observation during seven years of the region of the cecum following a barium enema in all colon examinations, whether done as a part of a general gastro-intestinal examination, or alone. Barium enemas have been used routinely in all gastro-intestinal examinations.

It is a well recognized fact that disease in the duodenum and gall bladder causes marked disturbances in the motility of the stomach. In general, the activity of the disease can roughly be determined by the degree of disturbance present in the stomach. With this in mind, it occurred to me that active inflammatory disease of the appendix should cause disturbance in the motility of the cecum. It was first considered in connection with the following case.

Five years ago the mother of a physician came in complaining of some discomfort in the right lower quadrant. She stated that she feared malignancy of the cecum, having

had a dear friend die of this condition only a short time before. A complete gastro-intestinal and gall-bladder examination was done, but the only finding of interest was extreme irritability of the cecum and ascending colon, so marked that it was impossible to visualize the structures satisfactorily. This was associated with marked tenderness upon deep palpation over the region of the cecum. Re-examination, after an antispasmodic, was recommended. This was done in about ten days and the spasticity, although much less marked, was still present. It seemed evident from this examination that there was no organic disease in the cecum or ascending colon. There was no suggestion of any other systemic disease, special attention being given to the possibility of pulmonary tuberculosis. In my report I stated that there was some possibility that the spasticity noted in the cecum might be associated with disease of

the appendix. The patient has had similar attacks at intervals since and has been re-examined at least four times. Varying degrees of spasticity have been present each time but the appendix has not been removed.



Fig. 10. Early carcinoma of the cecum with partial obstruction of the terminal ileum.

After observing this case I began to examine the right side of the colon with additional care in all cases. I soon discovered that, in practically all instances, contraction waves were present in the cecum when the colon was filled with opaque material. I found that it would be necessary to determine the range of normal contractions in the cecum and, with this in mind, a series of cases in supposedly normal young adults was examined (Figs. 1, 2, 3, 4). In all cases it was found that definite rhythmic contraction waves occurred in the cecum. In none of these cases were the cecum and ascending colon seen to empty, nor were the contractions sufficient to expel the barium even for a short time. No mass peristalsis was noted in the right side of the colon in any case and no irritability was noted in the left side of the colon. Only one series was examined because of the difficulty in securing satisfactory persons.

#### TECHNIC OF EXAMINATION

Catharsis, even within a period as long as 24 hours, is not advised when the possibility of inflammatory disease of the appendix is to be investigated. A barium enema may be given after the 24-hour observation in a gastro-intestinal examination, or alone. When it is given alone, it should be preceded by a single film of the entire abdomen. This film is of great assistance in detecting gallstones, urinary tract stones, calcified abdominal lymph nodes, dilated loops of the small bowel, indicative of small bowel obstruction, and other conditions which might be obscured after an injection of opaque material. The film should be examined carefully before the enema is given, for in some instances nothing more than the first film may be needed to fix the diagnosis. A suspension of barium sulphate in water at body temperature is used for the enema. It should be given slowly, preferably with the reservoir not more than 24 inches above the level of the patient. Before judgment is passed on the condition of the cecum and ascending colon, the structures should be observed carefully, after filling, at intervals for a period of at least four minutes. Many abnormalities are undoubtedly missed by too hasty observation. After the fluoroscopic examination, at least one large film of the entire colon should be made, using the Bucky diaphragm.

In all except one of the cases reported, the diagnosis was based only on the behavior of the cecum and ascending colon in the presence of a barium enema. However, in other cases, barium was given by mouth and, after an interval of about fifteen hours, the patient was examined with the fluoroscope, after which the enema was given as above described. When this type of examination is employed, additional information may be obtained. The appendix itself will be visualized in a high percentage of cases, although it seldom is when the enema is given alone. Its position, mobility, general appearance,

emptying time, etc., may be determined. These data may be of real value in diagnosis, especially in the presence of a low grade infection.

#### CONDITIONS NOTED IN THE PRESENCE OF DISEASE

Earlier in this paper it was stated that the cecum and ascending colon, in a supposedly normal individual, filled readily when a barium enema was given. Rhythmic contraction waves, normally present when these structures are moderately distended, were described. Spasticity was not noted in any case.

My observations would seem to indicate that, when the appendix is inflamed, the nervous mechanism of the cecum, and sometimes of the ascending colon, is disturbed, with resultant increased irritability, evidenced by varying degrees of spasm in the musculature of these structures. In the subacute and chronic cases, the irritability, in general, seems to be directly proportional to the degree of inflammation present. In the majority, the cecum and ascending colon can be filled, but they usually contract at intervals and may expel most of the opaque material. They may refill and contract alternately; more frequently they may remain contracted. In the low grade inflammatory type, the evidence of irritability, which may be slight, is often limited to the extreme dependent portion of the cecum near its junction with the appendix.

In many of the acute cases, generalized irritability is not present in the cecum or ascending colon. In some, the cecum fills quite readily and remains filled during the fluoroscopic examination. If there is any variation from normal, there is a hypotonicity. Just why this is the case I am not prepared to say, but it seems quite possible that this is due to a toxic nervous inhibition. This has most often been observed in cases in which evidence of infection has been pres-

ent for at least 24 hours, and it is quite possible that irritability was present earlier in the disease. It is unfortunate that this is true, for it detracts considerably from the value of this method of diagnosis in acute conditions. In other acute cases, a localized area of spasm, with more or less constant deformity, may be present even when, in general, the surrounding portions of the large bowel are hypotonic. In all of these types there may be a short interval after filling before evidence of irritability appears. This is especially true in the latter type. Some cases have shown irritability only after palpation over the cecum. It might be thought that palpation would cause spasm in normal cases, but this has not been true in those I have examined.

The irritability above described is entirely different from that seen in the condition commonly known as spastic colitis. In the latter, the irritability rarely extends proximal to the hepatic flexure, and, in my experience, it never involves the cecum. Much the same is true of all other forms of colitis except that due to tuberculosis or typhoid fever. Alfred Stengel, in his work entitled "Diseases of the Intestines," in Osler's "Modern Medicine," says that a true primary localized inflammation of the cecum, without appendicitis, does occur, although rarely. In these cases one might anticipate irritability of the cecum that could not be distinguished from the type above described.

#### APPLICATIONS AND LIMITATIONS

The type of examination above described, I believe, has a definite place in the diagnosis of inflammatory disease of the appendix. In acute cases, its use is limited because of the fact that disturbance in motility in the cecum and ascending colon may be absent. On the other hand, a properly given enema is without apparent danger and may give information of value. However, it must be definitely recognized that negative roentgen examinations do not rule out

the possibility of acute disease. This was effectively demonstrated in one of my cases.

It is in the diagnosis of the subacute and low grade, so called, chronic types of active inflammatory disease that I believe this

disease if the cecum or appendix is in contact with the tube. Early tuberculosis of the cecum may also be confusing until the chest is examined. Malignant disease in or near the appendix is another consideration,

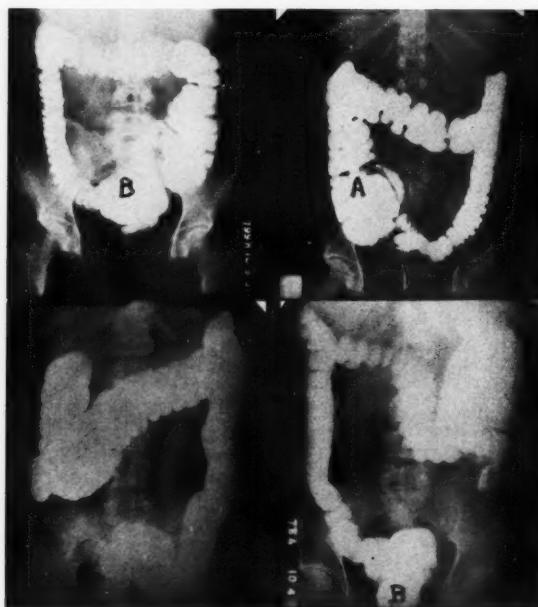


Fig. 11-A (above right). Case 1. Before operation, showing slight deformity of the cecum.

Fig. 11-B (above left). After operation.

Fig. 12-A (below left). Case 2. Before operation, showing spastic cecum and ascending colon behind first part of transverse.

Fig. 12-B (below right). After operation. Irregularity at the base of the cecum due to barium in the terminal ileum.

examination will find its greatest usefulness. In the chronic cases, especial care must be exercised before judgment is passed, for normal findings may be mistaken for abnormal, and, if the abnormalities are slight, the results of operation may be in direct proportion to the degree of disturbance.

Inflammation or other disease in structures immediately adjacent to the appendix or cecum may cause changes that cannot be distinguished from those resulting from disease of the appendix. For example, a right-sided salpingitis may simulate appen-

although a relatively rare one. With an undescended cecum, it may be impossible to distinguish between appendicitis and gallbladder disease. Carman reported one case of actinomycosis causing deformity of the cecum, but this condition is too infrequent to be a consideration in differential diagnosis.

#### CASE REPORTS

The following case reports have been selected as illustrative of various types of inflammatory disease of the appendix. All

have been operated upon and the pathologists' findings are reported. Some have been examined and operated upon recently, others as long as two years ago. In the earlier cases, the colons have been re-exam-

It has been through the courtesy and co-operation of Dr. Sydney E. Johnson, Director of the Roentgen-ray Department of the Louisville City Hospital, and the resident staff, that I have had an opportunity to

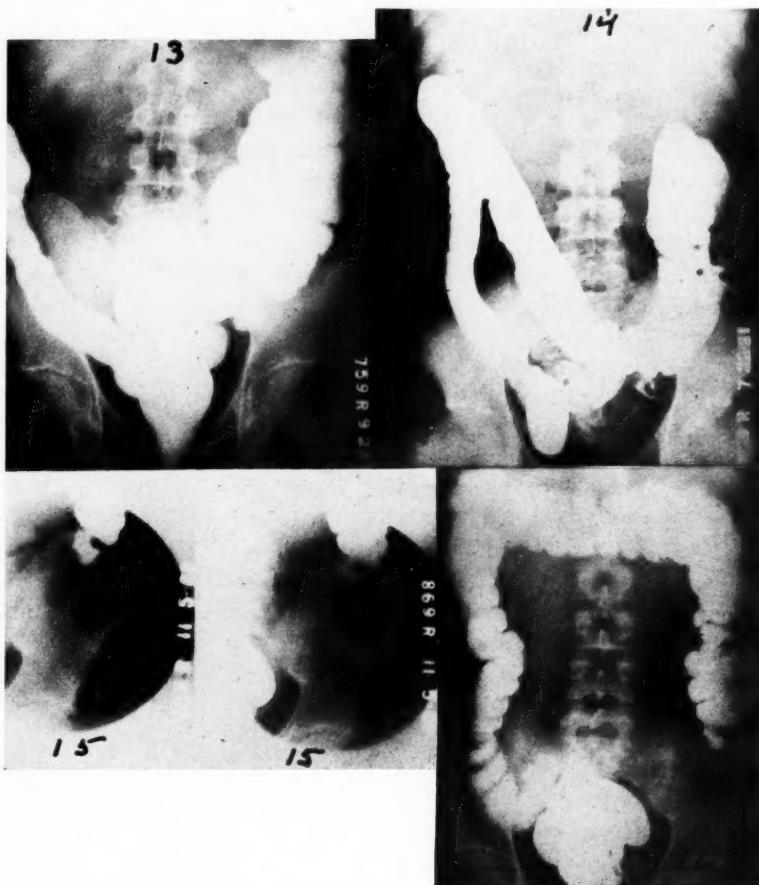


Fig. 13 (above left). Case 3. Film made with barium enema 18 months after operation. A pre-operative film was not available.

Fig. 14 (above right). Case 4. Film made with barium enema before operation, showing irritable cecum and ascending colon.

Fig. 15 (lower left). Case 5. Two small films made about two minutes apart, showing constancy of the deformity of the cecum.

Fig. 16 (lower right). Case 5. Roentgenogram made with barium enema before operation, showing irritable cecum and ascending colon.

ined during the last two months and the findings, together with a statement of the patient's condition, are reported. These represent less than one-third of the cases examined in which positive diagnoses have been made.

examine some supposedly acute cases. Dr. Johnson has been using a type of examination similar to mine for some time, and two of the cases reported were examined and diagnosed by him.

In one instance foreign bodies in an ap-

pendix (Fig. 5) caused sufficient discomfort to warrant surgical removal of the appendix. There was only the slightest spasm of the cecum in this case and microscopic examination of the removed appendix showed little evidence of inflammatory disease.

Dilated loops of the small bowel, typical of small bowel obstruction, were discovered by means of a preliminary film (Fig. 6), made before giving the enema. There was no irritability of the cecum in this case. I reported that I did not believe the appendix was actively inflamed, but that there was a mechanical obstruction of the terminal ileum. Operation showed that the obstruction was due to a band extending across the terminal ileum.

An unusually large group of calcified lymph nodes, medial to the cecum, was discovered in one case, in the preliminary film (Figs. 7-A, 7-B). The enema revealed no spasm of the cecum. All the tenderness present was sharply localized over the calcified glands. No operation has been done but I believe the glands, and not the appendix, are responsible for the symptoms.

A so-called inverted or undescended cecum was demonstrated by barium enema (Fig. 8-A). Another film (Fig. 8-B) of the same case showed the gall-bladder shadow, during cholecystographic examination, with the air-filled appendix lying beside it. One can readily appreciate the difficulties of differentiation between appendicitis and cholecystitis in this case.

Tuberculosis of the cecum secondary to advanced tuberculosis of the chest (Fig. 9) and carcinoma of the cecum (Fig. 10) were seen in two cases.

**Case 1.** This patient, white, female, age 25 years, gave a history of having had an acute attack of right lower quadrant pain three years previously, accompanied by nausea and vomiting, which lasted over a period of three days. Recurrent attacks had taken place at intervals. The patient developed an obstinate type of constipa-

tion during this period. A short time before examination, she developed a rather troublesome dysmenorrhea.

X-ray examination of the entire gastrointestinal tract, on Oct. 8, 1930, showed a constant deformity (Fig. 11-A) of the dependent third of the cecum, associated with some irritability. The appearance of the cecum suggested that there were adhesions about it and an opinion was expressed that the changes were secondary to an inflammatory lesion in the appendix, probably of low grade activity at the time of examination.

In his operative note, the surgeon said that there were adhesions about the base of the appendix and the cecum and numerous adhesions surrounding the tubes, ovaries, and uterus. An appendectomy and a panhysterectomy were done. The patient's convalescence was uneventful.

**Pathologic Report.**—Gross description: Some injection of vessels of serosa. No areas of hemorrhage. Microscopic description: Mucosa almost entirely replaced by fibrous tissue. Lumen entirely obliterated. Walls consist chiefly of fibrous tissue. A few areas of lymphocytic infiltration present. Diagnosis: Fibrosed appendix.

This patient was re-examined Oct. 9, 1931, when only a barium enema was administered. The colon was found to be normal in tone (Fig. 11-B). There was very slight deformity in the base of the cecum but no irritability was present. The patient informed me that she had been entirely free from symptoms since the operation. She also volunteered the information that the obstinate constipation had promptly disappeared and had not returned. She said that she considered herself to be in excellent health.

**Comment.**—It is impossible to say with certainty whether the condition in the pelvic organs or that in the appendix was responsible for this patient's symptoms. Certainly the appendix showed very little evidence

of any active inflammatory process at the time of the appendectomy. This case is cited as an example of one in which it may be impossible to determine by x-rays alone whether the appendix or the pelvic organs is the site of the inflammatory lesion.

Case 2. White, male, age 26 years. The patient came in giving a history of having had, three years previous to this examination, an acute illness characterized by acute pain in the right lumbar region, with tenderness in the right lower quadrant. At that time he was in the hospital for one week. A diagnosis of probable acute appendicitis was made, but he had a severe cold and was not operated upon. Since that time he had suffered from very obstinate constipation, headaches, and a sense of discomfort in the right lower quadrant much of the time.

A complete gastro-intestinal examination was done on Nov. 25, 1929. The stomach and small bowel were found to be normal. The appendix was visualized, lying partly behind the lateral third of the cecum and there was tenderness upon deep palpation over it. There was marked and constant irritability of the cecum and ascending colon (Fig. 12-A). In my report I stated that the findings were strongly suggestive of a low grade inflammatory condition in the appendix.

The patient entered the hospital on Dec. 18, 1929. The temperature was normal and the white blood cell count showed 8,400, with 68 per cent polymorphonuclear leukocytes. The pre-operative diagnosis was appendicitis, and an appendectomy was done.

*Operative Note.*—Diagnosis: Subacute appendicitis. Large inflamed appendix isolated and removed. No free pus or fluid.

*Pathologic Report.*—Appendix  $4 \times 0.25$  inch. Lumen patent. Contains fecal material. Microscopic description: Lumen large. Mucosa destroyed in some areas and in others very thin. All structures densely in-

vaded with leukocytes. Microscopic diagnosis: Acute appendicitis.

The post-operative convalescence was uneventful and the patient was discharged after 10 days.

A barium enema was given to this patient on Oct. 5, 1931, almost two years after his operation. All parts of the colon were found to be normal (Fig. 12-B). The patient stated that he had been entirely free from symptoms since the appendectomy, that he had gained weight, and was free from constipation and headaches.

*Comment.*—This patient had symptoms from his initial attack. Operation showed definite pathology and all symptoms disappeared promptly after the removal of the appendix. The location of the appendix evidently explained the peculiar posterior pain noted in the initial attack. There is every reason to believe that an active inflammatory condition persisted in the appendix from the first attack until the appendectomy.

Case 3. The patient, who was referred for an examination of the gall bladder and colon, gave a history of having had attacks of abdominal pain upon two occasions, one just a week before the present examination. The attending physician considered that the symptoms were likely due to a subsiding acute appendix, for there was some tenderness in the right lower quadrant and a blood count showed 11,400 white blood cells with 89 per cent polymorphonuclear neutrophils, but he thought it wise to rule out the possibility of gall-bladder disease.

A cholecystogram showed the gall-bladder function to be normal. A barium enema was then given and the cecum and ascending colon were found to be very irritable. There was some tenderness upon deep palpation over the cecum. In my report, I stated that I believed there was a subacute inflammatory condition in the appendix. June 16, 1930, six weeks later, as the patient had had two mild attacks similar to the previous ones, an appendectomy was done. Tem-

perature and laboratory findings at admission were normal. In the operative note the surgeon stated that there was evidence of chronic disease in the appendix, together with adhesions between it and the outer side of the cecum.

*Microscopic Description.*—Diffuse lymphocytic reaction. Increased fibrous tissue in submucosa. Diagnosis: Chronic appendicitis.

The patient was re-examined (Fig. 13) on Sept. 26, 1931. All parts of the colon were normal. The cecum was regular and not irritable. The patient stated that he had been entirely free from symptoms since operation.

*Comment.*—At the time of my examination, this case was evidently one of a subsiding acute appendix. At operation, six weeks later, there was relatively little evidence of active inflammation, but the recurrence of symptoms apparently indicated the infection was still present.

Case 4. The patient, white, male, age 20 years, was referred on July 22, 1931, for an examination of the colon. He gave a history of recurrent attacks of abdominal pain extending over a period of six years. During the attacks there was considerable tenderness upon palpation in the right lower quadrant. The last attack took place two months before this examination.

In my report, I stated that the cecum was somewhat irritable (Fig. 14). It was seen to contract several times and tenderness was noted upon deep palpation over the region of the cecum. It was my opinion that the irritability of the cecum was likely due to a low grade inflammatory condition in the appendix.

This patient entered the hospital on Aug. 17, 1931, having had another attack of abdominal pain. The blood examination at that time showed a white blood cell count of 11,550. Polymorphonuclear leukocyte count was 76 per cent. Temperature at admission was 99 degrees. The patient was operated

upon, and the appendix was found to be long, kinked, with adhesions. The appendix was removed.

*Pathologic Report.*—Gross description: Serosal vessels prominent. On section, the lumen of the distal portion is found to be filled with yellowish purulent fluid. The remainder is filled with semi-solid fecal material. Mucosa pale, yellowish brown and smooth. Microscopic description: Mucosa scarred in a few places. There are clumps of leukocytes beneath the serosa and also a few groups of leukocytes in the muscularis. The serosa is thin and the blood vessel walls are moderately thickened. Microscopic diagnosis: Chronic appendicitis.

The patient's post-operative course was uneventful. He is now out of the city, but, in conversation with a member of his family, in November, 1931, I was informed that he had been in excellent health since his operation and without abdominal symptoms of any type.

Case 5. The patient, white, male, age 29 years, was referred to my office Nov. 5, 1931, for x-ray examination of the colon. His chief complaint was recurrent attacks of abdominal pain extending over a period of several months. An unusually severe attack occurred three weeks before my examination. It was characterized by nausea and vomiting and pain localized in the right lower quadrant.

My examination revealed definite evidence of irritability in the cecum and ascending colon (Figs. 15 and 16). Three films were made and all showed a constant deformity of the dependent portion of the cecum, evidently spastic in origin. During the fluoroscopic examination, the cecum was seen to fill out at times, after which it contracted and the deformity reappeared. In my comments on the case, I stated that I felt there was little doubt but that there was a low grade active inflammatory condition in the appendix.

The patient entered the hospital one week

later and an appendectomy was done. In his operative note the surgeon stated that the appendix and cecum were surrounded by numerous adhesions. The appendix was subacutely inflamed.

X-ray examination of the colon showed rather marked irritability of the cecum (Fig. 17-A) and ascending portion associated with considerable sharply localized tenderness. This was thought to be due to

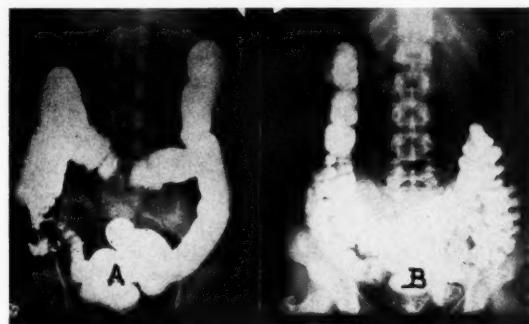


Fig. 17-A. Case 6. Film made before operation, showing irritability of the cecum.

Fig. 17-B. Film made 15 months after operation.

*Pathologic Report.*—Gross description: Serosa rough and reddened. Walls indurated. Lumen patent and empty. Petechiae in mucosa of distal third. Microscopic section: Moderate old fibrosis in submucosa and some recent fibrosis in mucosa. Mucosa edematous. There is a rather marked infiltration with eosinophils and plasma cells. In some areas the infiltration extends down into the submucosa. There are occasional areas of infiltration in the muscularis. Slight fibrosis of serosa. Microscopic diagnosis: Chronic appendicitis.

The post-operative course was uneventful. The patient left the hospital only a short time ago and it is too soon to determine the final results in this case.

Case 6. The patient, white, female, age 22 years, was referred for examination on June 16, 1930. She gave a history of abdominal discomfort, nausea, a sense of burning in the stomach, headache, and constipation extending over a period of a year. There had been no acute attacks of abdominal pain. She had lost approximately 28 pounds in weight during the previous three years.

a subacute inflammatory lesion in the appendix.

The patient was operated upon on July 12. The surgeon's operative note was as follows: "The appendix was chronically inflamed and contained two concretions. There were dense adhesions between the cecum and the lateral abdominal wall, making a small pocket in which the cecum was fixed. The adhesions were divided and the cecum allowed to resume its normal position instead of being rotated outward as it had been before. The other structures were normal."

*Pathologic Report.*—Gross description: The appendix measures 65 mm. in length. The diameter is fairly uniform. The lumen is patent throughout and contains two small fecaliths. Mucosa pale pinkish gray and moderately injected. Microscopic description: There is an increased amount of connective tissue in the submucosa and beneath the serosa. There are a few scattered patches about the blood vessels showing chronic inflammation. Microscopic diagnosis: Chronic appendicitis.

The post-operative course was uneventful.

This patient was re-examined Oct. 7, 1931 (Fig. 17-B). There was still just a little irritability of the cecum. The tone of the entire colon was found to be very much more satisfactory than was the case before.

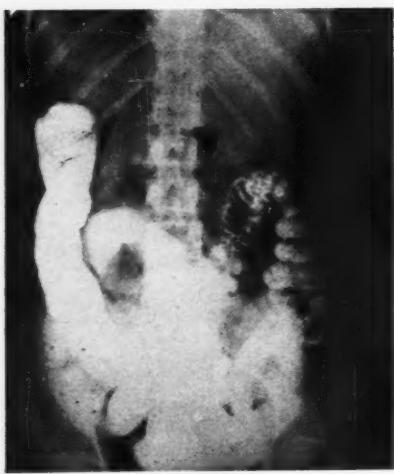


Fig. 18. Case 7. Film made before operation, showing irritability of the proximal colon.

The patient stated that she was very much better than she had been before her appendectomy. She had gained in weight but she still had some abdominal discomfort at times. The headaches had disappeared and the constipation was much less troublesome than before.

Case 7. The patient, white, female, was referred for examination on April 27, 1931, because of recurrent attacks of abdominal pain associated with tenderness in the right lower quadrant. The last attack had taken place a week before my examination.

A barium enema was administered. During the first part of the examination, the cecum filled out satisfactorily, but there was definite tenderness upon palpation over it. Both it and the ascending colon became quite irritable (Fig. 18) and contracted frequently following palpation over the cecum. During the latter part of the examination, it did not completely relax at any time. In

my comment I stated that I believed there was a low grade active inflammatory condition in the appendix.

The patient was admitted to the hospital six days later. At that time the white blood cell count showed 10,650 cells with a polymorphonuclear leukocyte count of 68 per cent. The temperature was normal. After an appendectomy the surgeon's operative note was: "The appendix was short and injected. The meso-appendix adjacent to the appendix was white, thickened, and indurated. Operative diagnosis: Subacute appendicitis."

*Pathologic Report.*—Gross description: The serosa shows a few fibrous tags. The walls are thin but firm. The lumen is patent and contains bloody mucoid material. Microscopic description: Mucosa thinned distally and replaced by dense, old, fibrous tissue which contains a moderate infiltration of plasma cells and lymphocytes, together with a few eosinophils. There is similar fibrosis of the submucosa throughout the length of the appendix and there is some leukocytic infiltration, although it is most marked in the tip. The serosa shows slight old fibrosis. In one area near the tip there is some recent fibroblastic tissue with a few newly formed blood vessels. Microscopic diagnosis: Healing appendix.

*Comment.*—It would seem that this case might well be classed as a subsiding acute appendix, judging from the leukocyte count and the pathologist's findings.

An attempt has been made to have this patient return for a re-examination, but so far it has been impossible to arrange a time convenient to her. The last reports are that she is in good health and free from abdominal symptoms.

Case 8. The patient, white, female, age 29 years, was referred for an examination of the colon on Aug. 22, 1931. She gave a history of very obstinate constipation extending over a period of years, together with discomfort in the abdomen, especially in the



Fig. 19-A (left). Case 8. Film made before operation, showing very irritable proximal colon.

Fig. 19-B (left). Film made eight weeks after operation. The cecum is still slightly irritable.

Fig. 20 (right). Case 9. Two films made about one minute apart, showing the constant deformity of the cecum and terminal ileum.

right lower quadrant, for the past month. Laboratory findings were normal.

In my examination (Fig. 19-A) I found that the proximal third of the colon filled satisfactorily, but almost immediately contracted. Several contractions resembling mass peristalsis were seen to start in the cecum and pass rapidly to the splenic flexure. During the latter half of the examination, the proximal third of the colon remained contracted the greater part of the time. There was some tenderness upon deep palpation over the cecum. I stated that the most likely cause of the above changes was an inflammatory condition in the appendix.

The patient entered the hospital shortly after the examination and appendectomy was done.

The surgeon stated that the tip of the appendix was several times the diameter of the proximal portion. In his opinion there was evidence of a subacute inflammatory lesion.

*Pathologic Report.*—Gross description: The appendix was congested and edematous, especially at the tip. Microscopic description: There are large masses of lymphocytes in the subserous lymph spaces. There is edema of the muscular coat and a small number of neutrophils occur among the lymphocytes. Microscopic diagnosis: Chronic and subacute appendicitis, early.

The post-operative course was uneventful. The patient was re-examined (Fig. 19-B)

eight weeks after being discharged from the hospital. All parts of the colon were found to fill satisfactorily, but there was still a little irritability in the cecum at times. The tone of the remainder of the colon was very much more satisfactory than was the case at the previous examination. The patient stated that, aside from the fact that she was still somewhat constipated, she was free from abdominal symptoms.

Case 9. The patient, white, male, age 50 years, came to the Out-patient Department of the Louisville City Hospital on Nov. 9, 1931. He gave a history of recurrent attacks of dull, aching pain in the abdomen extending over a period of two years. These were associated with considerable gas and constipation, but there was no history of vomiting during any of the attacks. Four days before coming to the hospital he began to suffer from more pain localized to the right lower quadrant. He stated that this had been the most severe of any of his attacks. A white blood cell count was done at that time and 11,050 cells, 78 per cent of which were polymorphonuclears, were found. The temperature was 99. He was admitted to the hospital the following morning. The temperature was 100 degrees but fell to normal in the evening and remained so until operation. The blood cell count was repeated and found to be 6,600 with 80 per cent polymorphonuclears. The

abdominal symptoms were rather vague at that time and because of this a barium enema was administered. The medial side of the cecum was found to be irritable and a rather constant deformity was present (Fig.



Fig. 21. Case 10. Deformity of medial side of the cecum, secondary to acute appendicitis.

20). The walls seemed to be relatively flexible. Quite a large amount of the opaque material escaped into the terminal ileum. This portion of the small bowel was narrow and irritable but at times it filled out quite well. Two films were made, and both showed much the same findings noted with the fluoroscope. The laboratory report stated that there was evidence of an extensive inflammatory lesion involving the terminal ileum, ileocecal valve, and a considerable portion of the cecum, probably due to an extension from the appendix.

When laparotomy was performed, the appendix was found to be acutely inflamed and surrounded by adhesions. There was an ulcer at the base, at which a perforation had evidently taken place and where a small, walled-off abscess was found. The walls of the terminal ileum and adjacent portions of the cecum and ascending colon were markedly thickened and indurated. An appendectomy was done. The patient is still in

the hospital. Considerable temperature was present following the operation but it is gradually subsiding to normal.

*Pathologic Report.*—Gross description: Specimen consists of an appendix measuring 6 cm. in length. Its diameter is 1.5 cm. and is uniform. Near the proximal end there is a ragged opening about four millimeters in diameter, extending entirely through the wall. The serosa is ragged with old connective tissue adhesions. The color is dark blood-red, evidently from an old hemorrhage. The wall varies from 5 to 7 mm. in thickness, cuts with resistance, and its sectioned surface has the appearance of scar tissue. There is a small amount of mucosa at the tip, but the remainder is ulcerated and hemorrhagic. The perforation mentioned above is evidently the result of ulceration from the mucosa outward. There is no fecalith.

*Microscopy.*—Sections of the tip show the mucosa intact, but the submucosa has old scar tissue. In the serosa there is also much scar tissue which is well matured, but contains a few lymphocytes in its outer portion. Other sections show the mucosa sloughed and, in one place, the muscularis and serosa are ulcerated. In all coats there is much scar tissue, the oldest being in the submucosa and in the outer coat next to the musculature. On the outer side there is a zone of blood clot which is organizing. The leukocytic infiltration varies from dense collections of lymphocytes surrounded by old scar tissue to large areas of polymorphonuclear cell infiltration. In these there is recent necrosis. The changes suggest former attacks of inflammation, some of which are apparently well healed, others in the process of healing and a recent one of a week or more duration, and the repair of this attack has begun. Diagnosis: Acute appendicitis, recurrent.

*Comment.*—The findings, when this patient presented himself for admission to the hospital, were not characteristic of an in-

flammaty disease of the appendix although they were suggestive. The x-ray findings were of considerable aid in determining the exact conditions present and were very well borne out at operation.

Case 10. The patient, white, female, was admitted to the hospital Nov. 6, 1931, complaining of abdominal pain of 18 hours' duration. A short time before coming to the hospital the pain localized in the right lower quadrant. The patient had vomited three times. There was no history of similar attacks.

Physical examination showed rigidity of the muscles on the right with rather extreme tenderness in the right lower quadrant, together with rebound tenderness. The white cell count was 20,000 with 92 per cent polymorphonuclear leukocytes. Temperature was 99.5 degrees.

A diagnosis of acute appendicitis was made but a barium enema was given in order to determine what changes might be present in the cecum and ascending colon. All portions of the colon filled very satisfactorily except that the medial side of the cecum was constantly irritable and a filling defect was present (Fig. 21). This appeared to be spastic in origin, for it partly disappeared at times. There was no generalized spasm of the cecum.

After completing the examination, I stated that the patient evidently had an acute appendicitis and that this was responsible for the filling defect noted. Before seeing other acute cases, I had expected to find generalized spasm of the cecum, but, when this one was examined, I realized that this was not a constant finding.

A laparotomy was performed and an acute appendix was found and removed. The pathologic report stated that the appendix was covered with exudate and the lumen was patent and contained mucopurulent material. The mucosa was eroded, reddish, and edematous. In the microscopic description it was stated that all of the coats

were involved in an inflammatory process in which there was diffuse infiltration of polymorphonuclear leukocytes, plasma cells, and lymphocytes. Some areas of hemorrhage were present. Microscopic diagnosis was acute appendicitis. The post-operative course was uneventful.

Case 11. The patient, white, female, was admitted to the hospital Oct. 21, 1931, complaining of abdominal pain of 12 hours' duration. This was associated with nausea and vomiting. Shortly before coming to the hospital the patient had localized pain in the right lower quadrant. Physical examination showed marked tenderness in the right lower quadrant. The blood examination showed that 15,000 white cells were present with 81 per cent polymorphonuclear neutrophils. Temperature 99.8 degrees. A diagnosis of acute appendicitis was made, but the patient was referred to the X-ray Department for a barium enema.

All parts of the colon filled satisfactorily, including the cecum. No irritability was noted and there was no evidence of any deformity in the outline of this structure.

After completing the fluoroscopic examination I stated that I did not believe the patient had acute appendicitis because the cecum was not deformed and no irritability was present. I was basing this entirely on the x-ray findings for the clinical ones were characteristic of acute appendicitis. This was one of the first acute cases that I had examined and I did not believe that an acute inflammatory process could be present without causing some disturbance in the motility of the cecum. A laparotomy was done and an acute appendix found. It was removed and the convalescence was uneventful. Unfortunately the films were lost and cannot be used to show the findings in this case.

*Comment.*—This case illustrates very well the fact that an acute inflammatory condition may be present and not cause any changes in the cecum. It shows that lack of findings in this type of examination do

not rule out with certainty the possibility of acute inflammatory disease of the appendix.

#### COMMENT

I cannot refrain from quoting a paragraph written by Carman more than a decade ago. He said: "On the whole, the value of roentgen signs of appendicitis appears to depend not only upon the intensity of the examiner's endeavor, but also, to some extent, upon the degree of his enthusiasm. Inasmuch as few normal appendices have been found by surgeons or pathologists, the diagnosis of appendicitis upon any ground whatever is not at all hazardous, but the novice should make sure that the appendix has not previously been removed, lest he mistake barium in the ileum for a shadowed appendix and draw his conclusions accordingly."

This is as true to-day as it was then. But it is not enough to diagnose appendicitis in all cases that will show some evidence of past disease, for, in a large percentage of these, the changes have no relationship to the patient's symptoms and an appendectomy will, in most instances, not produce results that are satisfactory either to the patient or surgeon. If our opinion is to be valued, we must go deeper and discover the cases in which the appendix is likely to be causing symptoms. To my mind, the logical working basis for this, in most instances, is an attempt to determine if active inflammation is present. Pathologists could aid us greatly, if, in addition to their regular report, they would state if, in their opinion, evidence of active inflammation is present and its degree.

The mortality from appendicitis is such as to give physicians in all branches of medicine grave concern, and the problem of diagnosis is of sufficient importance to merit our most thoughtful consideration.

#### SUMMARY

##### 1. Normal roentgen-ray findings in the

cecum and ascending colon after a barium enema are described.

2. Variations from normal in the presence of active inflammatory disease of the appendix are outlined.

3. Cases are presented illustrating the value of the roentgenographic examination in diagnosis of inflammatory disease of the appendix. Some of the cases were re-examined after operation and the findings are reported.

4. Barium given by mouth and followed by a barium enema after an interval of from 12 to 15 hours should give the most information in the majority of cases.

5. The final diagnosis in any case must be based on all the findings, clinical and otherwise, and not upon those of x-rays alone.

#### DISCUSSION

DR. EVARTS A. GRAHAM (St. Louis): I do not know why I was asked to discuss this paper because, as you all know, I am not a roentgenologist, and my information about these matters is far from expert. There are, however, one or two things that I would like to say about appendicitis. Chronic appendicitis has done more to discredit surgery than, I suppose, almost any other so-called diagnosis that is made. The difficulty, it seems to me, is largely what Dr. Bell has brought out, namely, it concerns itself with the matter of definition.

I am not speaking now about acute appendicitis. I take it that that offers no particular difficulty in diagnosis or no particular difficulty, theoretically, in treatment. Despite the fact that the mortality in acute appendicitis is disgracefully high throughout the country, the difficulties really do not exist to the same extent in that condition that they do in so-called chronic appendicitis.

There are some who take the extreme position that there is no such thing as a chronically diseased appendix. That is a position, which, in my opinion, is not justified. We surgeons know that frequently we relieve a patient of symptoms by removal of an appendix which contains fecoliths, or one which is the

site of recurrent acute attacks, or one which has become a so-called mucocele, or occasionally even one which appears relatively normal.

The difficulty which confronts us, however, is that in one case we will see an appendix which looks exactly like the appendix in another, yet the results in the two cases will not be at all the same. In one perhaps the result will be brilliant; in another, the patient will be no better, or perhaps he will be even worse after the operation.

When we appeal to the pathologist, we have again the same difficulty that Dr. Bell has brought out, namely, it is extremely difficult for a pathologist to tell us whether or not the picture which he sees in a particular appendix is sufficient to cause symptoms. We, as clinicians, are primarily interested, not so much in the changes noted by the pathologist under the microscope, as to whether or not they can be correlated with the patient's symptoms.

If you roentgenologists can help to define chronic appendicitis by functional changes which you see in your examination of patients, you will do much to remove this discredit from clinical surgery to-day. You are in a position to establish the picture of chronic appendicitis, insofar as it relates to clinical symptoms, much better than are the pathologists or surgeons, because, of course, symptoms are produced only by disturbed functions. Pathologic changes create symptoms only because they disturb the normal functions.

You who look through the fluoroscope and take x-ray films are able to note changes in function. After all, that is the chief value of the roentgen examination of the viscera. It is a means for testing functions of almost all the organs in the body. If you could see merely pathologic changes or anatomic defects, roentgen diagnosis would not be half so valuable.

I am not at all prepared to enter into any critical discussion of Dr. Bell's paper. He was kind enough to send me a copy of it, and I was tremendously interested in reading it. I have been greatly pleased, also, with the satisfactory results which he has recorded after operation on the cases in which he has utilized the method about which he has told you. I am a little sorry that he did not tell

us more about his failures. It may be that he has had none. I hope so, but it is interesting to hear the other side of the story.

Just a word about this question of functional diagnosis, that is, the diagnosis of disturbed functions. I think it would be a wise thing for everybody to remember that symptoms are produced only by disturbed functions. An appendix which is definitely diseased in the eyes of the pathologist may not produce any disturbed functions and, therefore, may not be the cause of the patient's symptoms. That is important to remember, because if such an appendix is removed from the patient, he may be no better than before.

There are many other disturbances in the abdomen causing symptoms which are often erroneously confused with chronic appendicitis, but it would be impossible for either Dr. Bell or myself to take them up in the course of a short discussion. As a practical clinician I would say that one of the most common ills which is not infrequently confused with chronic appendicitis, and which discredits operation for appendicitis, is ordinary constipation.

As a surgeon, I see frequently the results of operation on patients with chronic constipation—I see it perhaps more often than you roentgenologists do. We also see many patients who have been unwisely and injudiciously operated on because all the time they have had a disease of the gall bladder. The gall bladder has not even been examined because the pain was on the right side of the abdomen, and everyone thinks of appendicitis once the appendix has been incriminated.

I feel myself that a diagnosis of chronic appendicitis should not be made without a complete gastro-intestinal examination of the patient as well as a complete clinical examination. I would certainly be unwilling to submit myself to an operation for the removal of the appendix merely on roentgenographic evidence. However, I am perfectly willing to be convinced that I may be wrong on that point, and I hope that Dr. Bell's lead will enable us to tell with more precision about that matter.

DR. L. R. SANTE (St. Louis): It has not been my good fortune to find a uniformly sat-

isfactory method for the diagnosis of appendicitis. I think, therefore, that we must give our utmost consideration to this condition Dr. Bell has noted, the hyperirritability of the cecum. I am sure that, in certain instances, I have observed spasticity of the gastro-intestinal tract, but this does not seem to be confined to the cecum. In other words, this same hyperirritability may be present any place along the gastro-intestinal tract.

I recall clearly one instance of acute appendicitis with abscess formation, in which there was a spastic hour-glass constriction that completely divided the stomach. I recall another instance of a large appendiceal abscess which by pressure caused a rounded defect on the large atomic cecum. It thus appears that spasticity of the cecum cannot be considered uniformly present in appendicitis. That spasticity of the cecum does occur, however, I am quite convinced, but that it can be considered as pathologic I am not convinced.

It is difficult to check the reliability of one's findings in appendicitis. From the platform one pathologist made some such statement as this: "I can take out your appendix, or yours, or yours, or yours, and send it to the pathologic laboratory and find evidences of pathology." As was brought out in Dr. Graham's observation, although he may have had his appendix removed, the patient may continue with symptoms, thereby showing that the appendix was not the offending organ. In other words, the appendix may present evidences which are definitely pathologic and yet may not be the site of the trouble.

Our criterion for roentgen diagnosis of appendicitis has been on the following five points, which are given in the order of their importance:

1. A painful point directly over the appendix.
2. Malposition of the appendix, an excessively long appendix extending into the pelvis or up into the gall-bladder area, etc.
3. Restriction of mobility due to extrinsic adhesions, or restrictions of motility due to previous inflammatory processes interfering with peristalsis.

4. Inclusions in the appendix.
5. Delayed emptying. The fact that the appendix does not fill does not mean it is, or is not, pathologic.

I think that while we must give our utmost attention to Dr. Bell's observations, we are not justified in making any kind of absolute statement on findings of this sort, because they are apt to be caused by other lesions of gastro-intestinal character.

DR. A. DAVID WILLMOTH (Louisville, Ky.): Those of us who open the abdomen frequently know that we have in appendicitis two types of persons: one presents acute appendicitis, with diarrhea, and the other comes with constipation (or, if we want to use the old term, obstipation), which was most likely diagnosed by the doctor who first saw the case as intestinal obstruction.

As far as I know, Dr. Bell's observation is the first that has been made to try to classify this condition or to see what happens in this type of case. I am quite sure that if the Doctor had been able to follow his cases all the way through, or perhaps over a period of time, he would have found that the cases presenting spasticity at the head of the colon would eventually have had the diarrhea. They would have come to the operating table as cases in which the bowel had moved a number of times just previous, perhaps, to the removal to the hospital.

Those in which there was no notice of the rapid constriction of the head of the colon would eventually have come as cases of intestinal obstruction and been diagnosed as such, the blood count and Schilling differential count determining the surgeon's decision.

If there can be any indictment brought against Dr. Bell's paper, it is the question of injecting barium for observation in suspicious cases of an acute appendix with high blood count. In such cases, you might arouse an appendix into activity or you might burst the colon.

I want to take exception to the question of a chronic appendix. Is there such a thing as a chronic inflammation? I do not think so. Inflammation is an acute process brought about by bacterial invasion, usually of py-

ogenic variety; the irritation that you see in the appendix is a chronic hyperemia, generally the result of adhesions there. It is not an inflammatory process in any sense of the word. If it were, the patient would have to have something done.

After all, there are two places for studying pathology; one is the operating table and the other is the mortuary slab. That is where we see what really happens in a belly to cause trouble. One of the speakers very aptly said that it was hard to tell what is going on. In cases showing the most marked symptoms, if you open the abdomen you will find the appendix practically normal. In other cases in which there are no symptoms, no change in the blood count, you will find the appendix to be rotten. What is the difference? It is a question of the protection of the patient's system. Why does one get diarrhea? Due to irritation of Meissner's plexus and the Auerbach's plexus, there is stimulation of the gut. That is why a diarrhea is present. If there is a partial paralysis of the nerve supply, constipation or intestinal obstruction is present.

I think the Doctor is in a field in which he may be able to give the surgeon some valuable information, if he can follow his cases farther and can see what happens for the next few hours. As long as they are in no acute danger, there will be no objection to his following the case. If he wants to take plates as a record, all right. Personally I would much prefer a fluoroscope. In my own clinic I do not take plates of a suspicious appendix. I would much rather depend on the fluoroscope and see where I am putting my finger. If the patient is tender, I am pretty safe in saying that the trouble is about the appendix.

This brings me to another thought, and that is the matter of the chronic gall bladder, brought out by Dr. Graham. I am referring to the incision of 1.5 inches that is made when appendectomy is performed. I thought the day was over when incisions 1.5 inches long were made. When you open an abdomen, you make an incision long enough to make a diagnosis. Unless you do that, how do you know what else is in the abdomen? When you go down to the mortuary slab, you find that you missed the entire target. You would not have

done that if you had opened through a longer incision in the border of the right rectus muscle. The same incision will take you up to the gall bladder. I think Dr. Sante mentioned some important points, and among them is the question of how much you are going to rely on what you see there. I know of no absolute, sure sign of what is going on in the abdomen. The late beloved Dr. Deaver said a long time ago that no man living could tell you what was going on in the abdomen with an acute appendix. After many years of abdominal surgery, I want to say that I fully agree with what he said years ago. No man *can* tell what is going on there.

DR. F. C. CHRISTENSEN (Racine, Wis.): I am wondering how much of the deformity of the cecum may be due to its being, in many instances, from 50 to 75 per cent extraperitoneal. It would be interesting to study a series of cecums and verify on the operating table the relation of cecal deformity to the degree of peritoneal covering present. Adhesions, either congenital or following inflammations other than appendicitis, may cause the deformity.

Dr. Bell is right about the importance of a complete gastro-intestinal barium study. However, the expense incident thereto is often objectionable, even prohibitive, especially under present economic conditions. I have found it satisfactory to make 6- and 24-hour studies of barium meals in these cases, and which may be done at a nominal expense to the patient.

I should like to have Dr. Bell tell us what his findings of cecal deformities have been after barium meals. Sometimes it is difficult to obtain a good cecal filling with a barium enema, as well as being more expensive and time-consuming.

In his discussion Dr. Graham mentioned the frequent pitfalls into which a diagnosis of chronic appendicitis leads a surgeon. He said that if a gall-bladder study were made the result would be more correct diagnoses and fewer operations for chronic appendicitis. I should like to add that no operation for chronic appendicitis should be done until the question of pyelitis and ureteral strictures has been given serious consideration, especially in

women. Perhaps 50 per cent of the surgeon's failures to secure relief by removing a so-called chronic appendix may be charged to pyelitis and ureteral strictures.

DR. S. C. BARROW (Shreveport, La.): I believe that we have done a great deal of good down in my section in our work on examinations of the chronic appendix, and I take the stand that there is a difference between a chronic appendix and chronic appendicitis. I feel that radiologists have more to do with the chronic appendix than with chronic appendicitis.

The question is: Can we show whether or not we have a chronic appendix? One of the greatest fighters on this issue was our lamented friend, Dr. John Deaver. He performed 740 consecutive operations on what he called cases of chronic appendix, enumerating the pathologic findings. They were, as I remember them, a congested condition, an inflammatory condition, fibrous tissue formation, elongation and dilatation, clinging and fixation. He found those conditions in the 740 cases upon which he operated. Therefore, I say that if we can demonstrate those conditions pre-operatively, we can truthfully say that we can diagnose a chronic appendix.

Fluoroscopically the congestion and inflammations in an appendix are present by the sense of touch as responded to by the patient; and I believe that the painful point, fluoroscopically, is one of our strongest points in making the diagnosis of a diseased appendix. The fibrous tissue formation is shown by the irregularity in the contour of the appendix. Elongations and dilatations are, of course, present fluoroscopically and otherwise. Clubbing, fixation, and all of these diverse points that Dr. Deaver found in the 740 cases, are simple procedures to demonstrate roentgenographically.

Dr. Bell says that he cared nothing about x-rays—he later says it was because he could not rely upon his interpretations. The only advice that we could give to one in that state of mind would be to consult somebody on whom he could rely. I am strongly of the opinion that no examination of a chronic appendix is proper without a complete gastro-

intestinal study; barium by mouth, followed all the way through.

We owe a double obligation in examining any patient, and that is to make the diagnosis, or assist in it, and then see that the patient, if it lies within our power to do so, follows the proper course. I find that, when I examine a patient and feel convinced that he has a chronic appendix, it is far easier for me with my consultant to show that patient the condition and lead him to the operating room, than it would be if I talked to him on clinical symptoms all day long.

DR. BELL (closing): Dr. Graham has emphasized the functional basis of this type of examination. It is because of this basis that I believe it is of real value. Post-operative results have been gratifying in the large majority of cases that could be followed. However, in two, although there has been some improvement, many of the symptoms are still present. In both of these cases there was a large element of worry and nervousness. Generalized irritability of the colon, which seemed more marked in the proximal third, was present in both.

Dr. Sante described his procedure in examination of the appendix. I purposely have based my diagnosis largely, if not entirely, on the behavior of the cecum in this group of cases in order to determine its reliability. However, I believe the examiner should make use of all methods insofar as they have proven reliable. At the present time, I give barium by mouth 12 hours before examining the colon, as above described, and in my examination I observe with the fluoroscope the filling of the cecum, its general appearance, etc. If the appendix is filled, I note its position, mobility, type of filling, and determine if localized tenderness is present. In some cases the patient is examined later to determine the emptying time. I do not wish to give the impression that I believe that, by this examination, one can say which case should come to operation and which should not. I do believe, however, that an intelligent use of it will aid materially in determining in which cases satisfactory post-operative results may be anticipated.

## THE INFLUENCE OF FILTRATION ON SURFACE AND DEPTH INTENSITIES OF 200 K.V. X-RAYS<sup>1</sup>

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THE necessity of a filter for removing undesirable soft radiation has been recognized since the early days of radiotherapy. During the time when only comparatively low voltages were obtained, filters were commonly of aluminium, glass, leather, or combinations of these materials, and were established arbitrarily in various clinics. With the development of x-ray tubes to operate at higher voltages, and the introduction of instruments for measuring the radiation, the question of filtration began to be studied experimentally.

The criterion was established that, for radiation to be satisfactory for deep therapy, it should be homogeneous. For practical purposes, radiation is said to be homogeneous when its absorption curve, plotted to a semilogarithmic scale, is a straight line. At first, homogeneity was determined with respect to absorption in aluminium, since this metal was being used for other physical studies of the roentgen rays. Later, when it was recognized that homogeneity should be determined with respect to a substance more closely resembling tissue, water became generally used.

The thickness of aluminium, or glass, filter necessary to deliver radiation homogeneous with respect to absorption in water increased rapidly as higher voltages were attained, and it became expedient to use other metals. Iron, copper, and zinc were the most practical, particularly the two latter, which were found to be almost equivalent in filtering effect. Jüngling, in 1920, summarized the work which had been done up to that time, and concluded that from 0.5 to 0.75 mm. of copper or zinc was the

necessary and sufficient filter for radiation in the neighborhood of 200 K.V., the exact amount depending on the type of apparatus and tube (1). This, with 1 or 2 mm. of aluminium as a secondary filter, has remained fairly standard for deep therapy.

However, in studying the ever important question of how to increase the depth dose, experimenters found that one means was to increase the filter. In other words, the optimum condition had not been found when so-called homogeneity was reached. In a paper from the Memorial Hospital in 1923, the increase in depth dose with increase in copper filter for thicknesses up to 1.7 mm. of copper was discussed (2). Small increases in depth dose were found with increase in filter, but, in order to obtain these increased doses, it was found that the irradiation time had to be increased in a much higher ratio.

Such investigations as this showed that, from the point of view of the depth dose delivered, there was a certain advantage in increasing the filter. They emphasized, however, the economic difficulty of making such changes in a busy clinic where, if every treatment were made twice as long, fewer patients could be cared for. On this basis, it gradually came about that two standard filters were established, according to their practicability in a given institution, 0.5 mm. of copper if there was a great pressure of patients, and 2 mm. of copper if there were sufficient facilities to permit its use. Copper in a thickness of 2 mm. was not considered an optimum filter; it was simply a compromise to obtain the greatest possible depth dose compatible with a practical irradiation time.

There had been no reason for supposing

<sup>1</sup>Read before the Radiological Society of North America, at the Eighteenth Annual Meeting, at Atlantic City, Nov. 28-Dec. 1, 1932.

copper the best filter material, but it had several practical advantages. It could be readily obtained in a pure state, so that there would be no question of impurities in the metal affecting the quality or quantity of radiation transmitted by a given filter. It could be rolled into sheets of uniform thickness, and the layer necessary to effect the desired filtration was neither so thick as to be unwieldy nor so thin that it had to be handled with especial care. In 1923, Erskine and Smith made a study of a large number of materials (3). They determined the thicknesses of these substances which transmitted equal amounts of radiation in air, and then measured the absorption of the beams in water. Their conclusion was that elements of intermediate atomic weight were better than those of either higher or lower value. Copper, nickel, and zinc were grouped closely, and were considerably better than gold, which fell almost into the class with water and paraffin. Tin occupied an anomalous position, agreeing with gold for small depths of water, but approaching copper for greater depths. These authors did not make a detailed study of different thicknesses of their filter materials.

In 1928, Thoraeus made the observation that it is always uneconomical to use thick filters (4). For a given average quality of transmitted radiation, a greater quantity will be delivered by a thinner layer of a heavier element. He has developed a combination filter consisting of 0.4 mm. of tin plus 0.25 mm. of copper plus 1 mm. of aluminium, which he finds very efficient. He claims for it a considerably higher transmission (surface dose) than for 2 mm. of copper, with a slightly higher percentage depth dose. This would show it to be a very economical filter for practical use, when radiation of this quality is desired. About the same time, Lenz advocated a filter of 0.5 mm. of silver to replace 2 mm. of copper. He found that the two gave almost identical surface doses,

but that the silver filter delivered a somewhat greater depth dose.

In view of the relatively small amount of practical data available on filters, it seemed advisable to investigate the surface and depth doses obtainable when a number of different ones are used under conditions comparable to those used in therapy.

These doses depend on the target-skin distance, and on the irradiated area, as well as on the filter. It has been shown, however, that, for practical purposes, these effects are independent of each other (2). The effect of distance, for those greater than 50 cm., may be calculated by means of the inverse square law, for any filter and field. The effect of the size of the field has been carefully investigated and reported in the paper just referred to. By means of data tabulated in this paper, the change in depth dose with irradiated area may be calculated for any filter and distance. Experiments completed within the last few months have corroborated these findings (5). Accordingly the present investigation has been made for one target-skin distance, 50 cm., and one irradiated area, 100 square centimeters.

The x-rays used were supplied by a water-cooled Coolidge tube, operating at 200 K.V. and 30 ma., on an outfit with a mechanical rectifier. An aluminium water phantom was used, cylindric in shape, 37 cm. in diameter, and 32 cm. deep. At no time was the ionization chamber less than 15 cm. from the sides and bottom of the phantom. The spherical ionization chamber was of celluloid, about 1 mm. in wall thickness, coated on the inside with India ink, to make it conducting. It was 1.8 cm. in diameter, and was supported on a stem 0.5 cm. in diameter. This chamber was calibrated against the standard air chamber over a range of radiation from 100 K.V., unfiltered, to 200 K.V., with 5 mm. of copper filter. The total variation was found to be

8 per cent over a range of half value layers in copper from 0.1 to 2.5 millimeters.

The ionization currents were measured by means of the vacuum tube measuring device regularly used at Memorial Hospital, described elsewhere (6).

The filters used, together with the intensities of radiation transmitted by them, are listed in Table I. Radiation intensities have been given throughout this paper in terms of electrostatic units per second read on the measuring instrument, rather than in roentgens, because of the uncertainty which still attends the measurement in roentgens of very soft radiation, such as will be found in the depth of the water phantom, even with fairly heavy initial filtration. This will make no difference in any of the conclusions reached, since they are concerned with comparisons only, not with absolute values. The second and fourth columns in Table I give the actual values of the ionization currents in air and on the surface of the water phantom (chamber half submerged). The third and fifth columns give the relative amounts of radiation transmitted by the various filters, on a basis of that from 0.55 mm. of copper as 100 per cent. It is evident that these relative values are not influenced by the scattered radiation at the surface of the phantom. That is, for the qualities of radiation used in the experiment, the back-scatter is the same for all (see last column of the table). From this it is evident that the value for the intensity of radiation at the center of a 100 sq. cm. field on the surface of the phantom may be found from that in air by multiplying the latter by 1.266, for radiations within the quality range of these experiments, as given by a chamber of the type used in this work.

In Table II are given the percentage depth intensities, for each radiation, in terms of its value at the surface. There is no means here of relating actual amounts of radiation —this table supplies only *relative* depth in-

tensities.<sup>2</sup> It is seen that in every case, except for 8.6 mm. of aluminium, the radiation at 1 cm. depth, or when the chamber is just barely more than completely submerged, varies from that on the surface by only 1 or 2 per cent. At a depth of 3 cm., the variation in intensity is only 4 per cent between the highest and the lowest values, showing no advantage for the heavier filters. This is due to the fact that the variation in intensity is caused partly by absorption of the radiation by the water and partly by scattering. For small depths, the scattering effect is predominant, and it has been shown that it is the same for all the qualities of radiation used in the experiment. As the depth increases, it is to be expected that the absorption effect will become more pronounced, giving higher intensities for the more heavily filtered radiations. This is, in fact, noticeable at a depth of 5 cm., and increases with increasing depth. The differences for different filters, however, are never very great. At a depth of 10 cm., an increase in filter from 0.5 to 2.16 mm. of copper has increased the intensity by only 6 per cent, and from 0.5 to 4.4 mm. of copper by only 15 per cent. With regard to the use of aluminium secondary filters, it would seem that, in the case of copper primary filters, they are of little assistance in increasing the depth dose. However, it must be remembered that the ionization chamber used had a wall of more than 1 mm. of celluloid, and this would absorb any very soft secondary radiation from the copper reaching the surface of the water, so that it would not register in the ionization current. As a matter of fact, there is such a soft radiation from copper, capable of traversing 15 cm. of air, but absorbed completely in about 1 mm. of tissue. Therefore, if the filter is within 15 cm. of the skin, this radiation must be removed, otherwise it will contribute to the production of

<sup>2</sup>Depth doses are, of course, proportional to depth intensities for a given amount of radiation on the surface.

TABLE I.—AMOUNTS OF RADIATION TRANSMITTED BY VARIOUS FILTERS  
200 k.v., 50 cm. TARGET-SURFACE DISTANCE, 100 SQ. CM. FIELD

Filter mm. metal	Amount of radiation				Back-scatter Percentage	
	In air		In phantom (chamber half submerged)			
	E.S.U.	Percentage	E.S.U.	Percentage		
4.4 Cu + 2 Al	0.168	13.1	0.210	13.0	25	
4.4 Cu	0.182	14.2	0.224	13.8	23	
2.16 Cu + 2 Al	0.392	30.8	0.500	30.9	28	
2.16 Cu	0.430	33.7	0.549	33.9	29	
1.10 Cu + 2 Al	0.712	55.5	0.900	55.5	26	
1.10 Cu	0.790	61.5	1.008	62.0	28	
0.55 Cu + 3 Al	1.050	81.8	1.33	82.0	27	
0.55 Cu + 1 Al	1.195	93.0	1.51	93.2	26	
0.55 Cu	1.275	100	1.62	100	27	
0.45 Pb	0.342	26.8	0.440	27.1	29	
0.30 Pb + 2 Al	0.521	40.6	0.678	41.8	29	
0.30 Pb	0.598	46.6	0.759	46.7	27	
0.74 Sn	0.408	32.0	0.512	31.6	25	
0.56 Sn	0.545	42.7	0.682	42.2	25	
0.37 Sn + 2 Al	0.676	53.0	0.867	53.5	28	
0.37 Sn	0.788	61.8	0.998	61.6	27	
Thoraeus	0.619	48.1	0.781	48.3	26	
0.5 Ag + 2 Al	0.420	32.7	0.520	32.1	24	
0.5 Ag	0.462	35.9	0.579	35.7	25	
8.65 Al	1.42	112	1.81	112	27	

TABLE II.—PERCENTAGE DEPTH DOSES OBTAINED WITH VARIOUS FILTERS  
200 k.v., 50 cm. TARGET-SURFACE DISTANCE, 100 SQ. CM. FIELD

Filter mm. metal	Depth—centimeters						
	0*	1	3	5	7	10	15
4.4 Cu + 2 Al	100		86.3	67.6		36.7	
4.4 Cu	100	102	87.0	68.3	54.0	37.6	19.6
2.16 Cu + 2 Al	100		87.3	66.0		34.4	
2.16 Cu	100	101	87.3	66.5	51.4	34.6	17.5
1.1 Cu + 2 Al	100		86.5	67.0		34.4	
1.1 Cu	100	102	87.2	66.6	52.0	33.9	16.3
0.55 Cu + 3 Al	100		86.8	67.0		33.1	
0.55 Cu + 1 Al	100		86.8	66.6		33.1	
0.55 Cu	100	101	86.1	65.6	50.1	32.6	15.1
0.45 Pb	100	101	85.8	65.8	51.2	34.5	16.4
0.30 Pb + 2 Al	100		86.8	66.8		33.1	
0.30 Pb	100	102	86.2	66.5	50.4	32.7	15.5
0.74 Sn	100	102	86.5	66.2	52.8	35.8	18.2
0.56 Sn	100	102	86.8	66.8	52.1	35.1	17.2
0.37 Sn + 2 Al	100		86.2	68.2		33.6	
0.37 Sn	100	102	85.0	65.9	50.1	32.3	15.6
Thoraeus	100	102	87.7	67.4	52.5	34.8	16.9
0.5 Ag + 2 Al	100		88.8	68.1		35.6	
0.5 Ag	100	101	86.5	66.4	50.1	34.5	17.2
8.65 Al	100	97	86.6	63.0	47.0	29.8	13.5

\*The ionization chamber was half submerged for 0 depth.

an erythema, while adding nothing at a depth. In other words, the relative depth dose will be less. In the case of the tin and silver, the secondary radiation is hard enough to penetrate the celluloid chamber,

reason, lead is less efficient as a filter for deep therapy than substances of somewhat lower atomic number.

As for the actual *amounts* of radiation delivered in a given time, some information

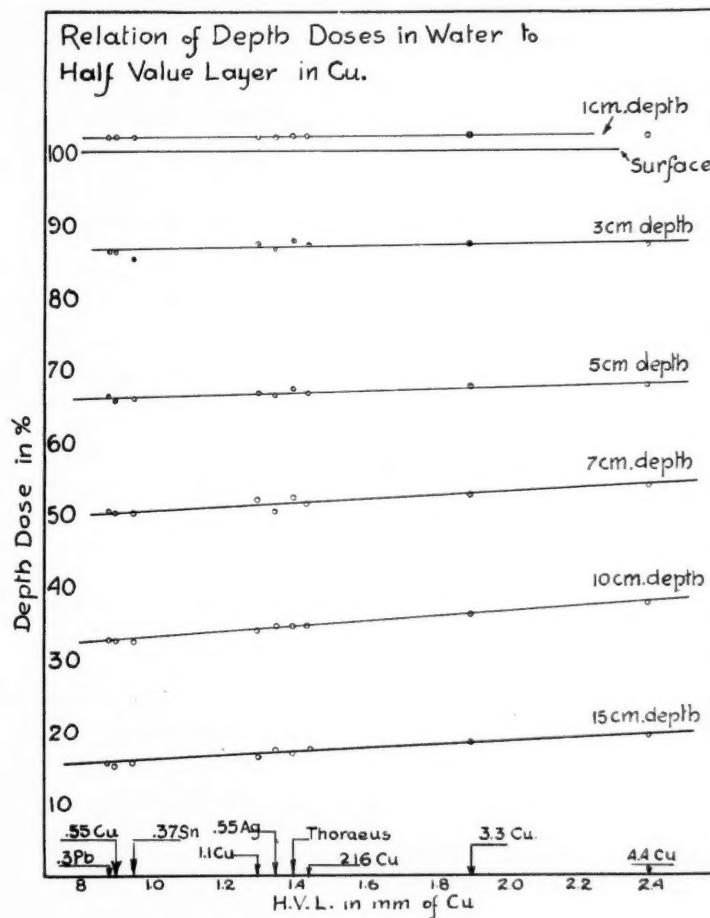


Fig. 1.

and, accordingly, the aluminium secondary filter shows an advantage. Lead, being a more effective filter for the harder rays than substances of lower atomic number, transmits a beam from which a higher percentage of them have been removed, and which is, therefore, softer, on the average, than for the other filters. Such a beam will deliver a smaller relative depth dose. For this

may be obtained from Table III. Here, for a certain group of filters, are listed both the percentages and actual depth intensities. At the beginning is 4.4 mm. of copper, and, at the end, 0.55 mm., the extreme filters used. Between these are listed five which give approximately the same depth intensities as 2 mm. of copper. From these data it is evident that, for a very small increase in in-

TABLE III.—COMPARISON OF AMOUNTS OF RADIATION DELIVERED AT VARIOUS DEPTHS WITH DIFFERENT INITIAL FILTRATIONS  
200 K.V., 50 CM. TARGET-SURFACE DISTANCE, 100 SQ. CM. FIELD

Filter mm. metal		Depth—centimeters					
		0*	3	5	7	10	15
4.4 Cu	E.S.U. %	0.224 100	0.195 87.0	0.153 68.3	0.121 54.0	0.084 37.6	0.044 19.6
2.16 Cu	E.S.U. %	0.059 100	0.485 87.3	0.365 66.5	0.282 51.4	0.190 34.6	0.096 17.5
0.45 Pb	E.S.U. %	0.440 100	0.377 85.8	0.294 65.8	0.225 51.2	0.152 34.5	0.072 16.4
0.56 Sn	E.S.U. %	0.682 100	0.592 86.8	0.456 66.8	0.355 52.1	0.240 35.1	0.117 17.2
0.5 Ag	E.S.U. %	0.579 100	0.500 86.5	0.384 66.4	0.290 50.1	0.200 34.5	0.100 17.2
Thoraeus	E.S.U. %	0.781 100	0.685 87.7	0.526 67.4	0.410 52.5	0.272 34.8	0.132 16.9
0.55 Cu	E.S.U. %	1.62 100	1.40 86.1	1.06 65.6	0.810 50.1	0.528 32.6	0.244 15.1

\*For 0 depth the chamber was half submerged.

TABLE IV.—COMPARISON OF CHANGES IN DEPTH DOSE AND IRRADIATION TIME OBTAINED BY CHANGING FILTER AND BY CHANGING TARGET-SKIN DISTANCE  
200 K.V., 100 SQ. CM. FIELD

Constant distance—50 cm.				Constant filter—0.5 mm. Cu			
Filter mm. metal	E.S.U. at surface	% depth dose 10 cm.	Irradiation time for given surface dose	Distance cm.	E.S.U. at surface	% depth dose 10 cm.	Irradiation time for given surface dose
0.55 Cu	1.62	32.6	1.00	50	1.62	32.6	1.00
2.16 Cu	0.60	34.5	2.70	60	1.12	35.0	1.45
0.5 Ag	0.58	34.5	2.80	70	0.84	36.0	1.94
Thoraeus	0.78	34.5	2.08	85	0.56	37.6	2.90
4.4 Cu	0.18	37.6	8.90	100	0.40	38.8	4.00

tensity of radiation at a depth, a very great decrease occurs at the surface, so that the delivery of a given dose (total quantity) will take very much longer with the higher filters. The data are tabulated in electrostatic units per second. Assume that a total of 1,000 e.s.u. is necessary for one erythema dose. With a filter of 0.55 mm. copper,

this quantity will be delivered on the surface in 620 seconds, or 10.3 minutes. In this time, 32.6 per cent of an erythema dose will be delivered at a depth of 10 centimeters. With a filter of 2.16 mm. of copper, the time necessary to deliver one erythema dose will be 30.5 minutes, or three times as long as for the 0.5 mm. filter, with

a gain of only 6 per cent in the depth dose. For the same gain in depth dose, the Thoraeus filter will deliver the required surface dose in 21.4 minutes. It is, therefore, much more efficient than 2 mm. of copper.

These comparisons are brought out in the first part of Table IV. Here are tabulated the irradiation times necessary to deliver the same quantity of radiation on the surface, for certain selected filters. In administering this dose on the surface, the 4.4 mm. copper filter will deliver a 15 per cent greater dose at a depth of 10 cm. than the 0.55 mm. copper filter, but it will take 8.9 times as long to accomplish it. In this table, again, the superiority of the Thoraeus filter over others in its own class is brought out.

In contrast with the results shown in the first part of this table are those in the second part. Here are shown the changes in depth dose and irradiation time brought about by changing the target-skin distance. In this case, a 15 per cent increase in the dose at a depth of 10 cm. is obtained by increasing the distance from 50 to 85 cm., with an exposure time for the second distance only 2.9 times as long as for the first. It is evident from these results that it is much more efficient to increase depth dose by increasing the target-skin distance than by increasing the filter, for filtrations higher than 0.5 mm. of copper.

In all the above discussion, nothing has been said of the possible advantage in cancer therapy of the harder types of radiation. From the point of view of therapy, the problem becomes very much involved at this point. There is some evidence that rays of shorter wave length are more advantageous in some cases. On the other hand, with sufficient increase in filtration to affect materially the quality of the radiation, the time of treatment becomes so great that it cannot be completed at a single sitting. Between treatments there is time for partial recovery in the irradiated tissues. If normal and malignant tissues recover from radiation

effects at the same rate, the effect of this recovery on the course of the disease may be insignificant. On the other hand, if the rates are different, it will have an important bearing on the method of choice for irradiation. The entire problem is outside the scope of this paper, which can deal only with intensities or quantities of radiation as determined by ionization measurements.

Absorption curves were made for the different radiations studied, in copper and aluminium, to see if any method could be found of determining the depth doses from measurements made in air. In Figure 1 is given a scheme whereby the half value layer in copper, as determined in air, and the percentage depth dose, at various depths in water, are related. Each line represents the percentage intensities, at specified depths, for radiations having half value layers as indicated on the horizontal scale. The experimental points for all the copper filters used, together with certain silver, lead, and tin filters, and the Thoraeus compound, are given. Straight lines fit these very well, the greatest error for any point being less than 3 per cent. Therefore, within a range of half value layers in copper from 0.8 to 2.5 mm., as soon as the half value layer for a given radiation is known, depth doses may be read directly from these curves.

An attempt has been made to compare these values with those in the literature. Unfortunately, few authors give the half value layer for the radiations with which their depth doses were determined. However, no values have been found which disagreed seriously with these, if measurements were made with small "air-wall," graphite, or horn chambers. (Photographic measurements give uniformly higher results.) In particular, our own earlier data, and those given by Glocker and Kaupp, Grebe and Nitzge, Sievert, and Thoraeus, agree within a few per cent with the values obtained from these curves (2, 7, 8, 9, 4).

It is evident, therefore, that this chart

may be used, with reasonable assurance of the accuracy of the data obtained therefrom, for determining depth doses without actually making measurements with a water phantom. For radiation at 200 K.V.P. (sphere gap), 50 cm. target-skin distance, 100 sq. cm. field, the values may be read directly from the chart. For the same voltage, but for other distances and fields, they may be calculated from these by the methods already described. No tests have been made for other voltages. However, for values not very different from 200 K.V., the chart will probably give good approximations to the depth doses.

#### SUMMARY

For 200 K.V. x-rays, with a 50 cm. target-surface distance and an irradiated field of 100 sq. cm., the intensity of radiation reaching various depths in a water phantom has been measured, for a wide range of initial filtrations. These filters include a number of thicknesses of copper, tin, and lead, and 0.5 mm. of silver, with and without aluminium secondary filters, and the special compound filter of Thoraeus.

Other fields and distances were not used because it has been shown previously that the effects due to these factors are independent of the filter, within the limits used in practice.

The relative amounts of radiation transmitted by the filters were found to be the same, whether measured in air or on the surface of the phantom, showing that the back-scatter at the surface was the same for the qualities of radiation included in this study. It amounts to 26.6 per cent of the intensity of the direct beam.

The intensity of all the radiations at a depth of 1 cm. was slightly higher than at the surface. At a depth of 3 cm., it was about 87 per cent of the surface value for all the filters tested. At greater depths, the heavier filters began to show somewhat

higher intensities, but there was no marked gain before a depth of 10 cm. had been reached.

Due to the effect of the walls of the ionization chamber, it was impossible to determine quantitatively the advantage of secondary filters of aluminium in increasing the depth doses.

In order to utilize the greater intensities from the higher filters in delivering greater depth doses, it is necessary to use relatively very long irradiation times.

The same gain in depth dose may be obtained by increasing the target-skin distance, with a considerably smaller increase in irradiation time.

The depth dose in water has been correlated with the half value layer of the radiation in copper. A scheme is offered whereby depth doses for any radiation within the range of the experiments may be obtained as soon as the half value layer in copper is known.

In conclusion the authors wish to acknowledge their indebtedness to Dr. Failla, who suggested the problem, for his interest and advice during the course of the work. They desire to thank Messrs. R. C. Woods and E. F. Moran for assistance in making measurements and calculations. They also wish to thank Dr. Lenz for his courtesy in lending them the silver filter.

#### BIBLIOGRAPHY

- (1) JÜNLING, OTTO: Untersuchungen zur chirurgischen Röntgentiefentherapie. *Strahlentherapie*, 1920, X, 501-584.
- (2) FAILLA, G., and QUIMBY, E. H.: The Economics of Dosimetry in Radiotherapy. *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1923, X, 944-967.
- (3) ERSKINE, A. W., and SMITH, S. W.: A Comparative Study of the Efficiency of Various Filter Materials. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1923, X, 881-883.
- (4) THORAEUS, ROBERT: A Study of the Ionization Method for Measuring the Intensity and Absorption of Roentgen Rays, and of the Efficiency of Different Filters Used in Therapy. *Acta Radiol.*, 1932, Supp. XV.
- (5) FAILLA, G., QUIMBY, E. H., MARINELLI, L., and ROSE: The Relative Effects Produced by 200 K.V. X-rays, 700 K.V. X-rays, and Gamma Rays. Part I, The Distribution of

Radiation in a Water Phantom. (To be published in Am. Jour. Roentgenol. and Rad. Ther., 1933.)

(6) FAILLA, G.: A New Instrument for Measuring X-radiation. *RADIOLOGY*, October, 1930, XV, 437-448.

(7) GLOCKER and KAUPP: Über eine in Bezug auf die R-Einheit von der Qualität der Strahlung Unabhängige Fingerhutkammer und über die Messung der Streusatzdosis im Wasserphantom. *Strahlentherapie*, 1926, XXIII, 447-462.

(8) GREBE and NITZGE: Tabellen zur Dosierung der Röntgenstrahlen. *Strahlentherapie*, 1930, Supp. 14.

(9) SIEVERT, ROLF: Eine Methode zur Messung von Röntgen-, Radium-, und Ultrastrahlung nebst einige Untersuchungen über die Anwendbarkeit derselben in der Physik und der Medizin, mit einem Anhang enthaltend einige Formeln und Tabellen für die Berechnung der Intensitätsverteilung bei  $\gamma$ -Strahlungsquellen. *Acta Radiol.*, 1932, Supp. 14, pp. 1-179.

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### STANDARDIZATION OF ROENTGEN DOSAGE BY MEANS OF METHYLENE BLUE<sup>1</sup>

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THE ionization produced by roentgen rays in air can be determined with considerable accuracy if the measurements are properly made and adequate precautions are taken. There are, however, several reasons why it would be of advantage to have available as well a simple and satisfactory chemical method for measurements of x-ray dosage. It seems probable that such a method can be worked out, for many organic substances undergo changes when they are irradiated while in solution.

A dilute aqueous solution, containing substances built up from light atoms, has approximately the same absorption and scattering abilities as tissue. Containers filled with the solution of such a substance may be sealed and sent to different places for irradiation and returned to the central laboratory for examination. Such a method would make it easy to obtain reliable standards for the different x-ray machines without very much expense and in the absence of persons with enough training in physics to handle delicate ionization apparatus.

In order that a chemical method for measurements and standardizations of roentgen dosage may become practical, the following requirements must be fulfilled:

1. Absorption and scattering of roentgen rays in the medium must approximate that of tissue.
2. The chemical change to be measured must have a simple relation to the dose. The same dose must produce the same change at all times.
3. The medium must be stable enough so that it may be left for at least some few days before measurements are made.
4. The method for determining the amount of change must be relatively simple and should permit determination of the dosage to an accuracy of at least 5 per cent.
5. The medium (solution) should be easy to obtain and reproduce.
6. The change needed for measurements must be produced by a reasonable dose.
7. A fairly small amount of solution should be sufficient for each exposure.

Although a number of pitfalls have to be avoided, we believe these requirements can be fulfilled by a properly prepared solution of methylene blue. It is our intention to describe how we succeeded in overcoming some of the difficulties, how the solutions were prepared and irradiated, and how the measurements were carried out. Some of the details will be omitted as they have already been described in an earlier publication (4).

<sup>1</sup>Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

It is necessary to have in mind that the effect of radiation upon the dissolved substance is influenced by the solvent. In all our experiments distilled water was used. It was necessary to use very dilute solutions in order that the change produced by a reasonable amount of radiation could be determined with fair accuracy. After having tried a number of substances, we chose methylene blue as suitable because it was influenced considerably by irradiation and because the color change could be measured simply and quickly by means of a spectrophotometer. Other substances may be found to be more suitable (1); it will, however, undoubtedly be necessary to take the same precautions with them as with methylene blue.

*A. Determination of Concentration.*—In order to weigh out the methylene blue correctly, it is necessary to recrystallize the commercial U.S.P. product and dry it carefully. About 0.0016 mg. per c.c. of water was found to be a suitable concentration for the preliminary measurements. A spectrophotometer was used to determine the absorption curve (1). After it had been found that the maximum absorption was in the red region at a wave length of about 6,700 Å.U. it was considered necessary to measure the absorption at this wave length only, and to use this absorption as a measure of the concentration and of the change due to roentgen irradiation. As a check, the absorption at 5,000 Å.U., at which point the methylene blue transmits light freely, was sometimes also determined. With an absorption tube 10 cm. long the extinction coefficient before irradiation was found to be 0.316. When new solutions were made up, they were always so examined and the concentration determined by the absorption, rather than by the weight of the methylene blue. After a portion of the solution had been irradiated with roentgen rays, its absorption at the above mentioned wave lengths was again measured. Before the method can be used

for standardization, a curve has to be obtained experimentally showing the relation between the dose and the color change, or percentage decomposition.

*B. Care of Solution.*—Since the color of methylene blue is to some extent affected by exposure to light (especially ultra-violet), it is necessary to keep the solution sealed in light-tight containers until the time comes to make the measurements. If care is taken, the solution will keep for at least several weeks.

For the first series of experiments, each time about thirty cubic centimeters of solution was sealed in a glass container and placed inside the x-ray tube drum at a distance of 65 cm. from the target. No filter was used. The voltage and the current were usually kept at 200 K.V. and 30 ma., respectively.

*C. Effect of Impurities.*—The first difficulty encountered was due to impurities. We soon found that very minute quantities of organic compounds might have a pronounced effect on the amount of methylene blue changed. Small amounts, one at a time, of the following substances were then added: Ethyl alcohol, acetone, phenol, sucrose, and calcium chloride. All of them, with the exception of the inorganic compound, calcium chloride, had a pronounced effect in that they reduced the change produced by the radiation. This proves that extreme care must be taken in order that no organic impurities accidentally get into the solution before it has been exposed to roentgen rays (4).

*D. Influence of Hydrogen Ion Concentration.*—When impurities and exposure to light were guarded against, we found that very good agreement could be obtained in a series of measurements. Two such series with solutions made up on different occasions did not, however, agree with one another. This led us to suspect that the sensitivity may depend upon the hydrogen ion concentration, which may have been slightly different in the two series. Portions of a

new solution were made alkaline and acid by means of small amounts of sodium hydroxide and hydrochloric acid, respectively. The  $\text{pH}$  was calculated from the percentage concentration of the solution. Tubes filled with the different portions were placed side by side inside the x-ray tube stand and irradiated for the same length of time, 22 minutes (Table I).

TABLE I.—EFFECT ON SENSITIVITY BY ADDITION OF HCl AND NaOH TO THE METHYLENE BLUE SOLUTION (FIG. 1)

$\text{pH}$ calculated	Added	Percentage change	Photometer reading
11.3	NaOH	84	29.0
10.3	NaOH	74	22.3
5.6	$\text{H}_2\text{O}$	64	16.6
3.3	HCl	51	10.8
2.3	HCl	10	3.1
1.3	HCl	1	1.9

It can be seen that the change produced depends upon the amount of acid or base added, the alkaline solutions being more sensitive. These solutions are, however, also less stable. We, therefore, decided that it was best, at least for a preliminary study, to use a  $\text{pH}$  of about 7. In order to keep the  $\text{pH}$  constant, it was necessary to use a buffer solution and to measure the hydrogen ion concentration with considerable accuracy (2). For these measurements, a Bailey type of hydrogen electrode,<sup>2</sup> which is made of gold, was used. Platinum black was deposited upon it by electrolysis in a water solution of platinic chloride. The other half cell was a saturated calomel electrode which was connected with the Bailey cell by means of a saturated potassium chloride liquid junction and agar bridge. The hydrogen for the Bailey cell, which was obtained from a hydrogen pressure tank, was purified by passing it over hot platinized asbestos and through dilute solutions of potassium permanganate, potassium hydroxide, sulphuric acid, and water. The electromotive force was determined by means of a "Queen" potentiometer and the  $\text{pH}$  calculated from the

formula  $\text{pH} = 16.9 (V - 0.246)$ . An air bath was used to keep the temperature as near constant as possible; no correction was made for barometric pressure or temperature. Sorenson's phosphate buffer with a  $\text{pH}$  of 6.8 was used for the solvent. In about 300 c.c. of boiled distilled water, 2.969 gr. of  $\text{Na}_2\text{HPO}_4$ ,  $2\text{H}_2\text{O}$  and 2.2695 gr. of  $\text{KH}_2\text{PO}_4$  were dissolved. A calculated quantity of a concentrated methylene blue solution was added and the mixture was made up to 500 c.c. with boiled distilled water. This gave a concentration of 0.0015 mg. methylene blue. The  $\text{pH}$  was found to be 6.8.

*E. Change of Sensitivity of the Solution with Age.*—A new batch of buffered solution was made up and used immediately. The sensitivity was, surprisingly enough, not nearly so great as that of the older solution. Next day it had increased, however, and the question then arose: Could the buffer slowly alter the methylene blue solution in such a way as to increase the sensitivity to x-rays without affecting the color before irradiation? The results of the measurements given in Table II answer this question in the affirmative.

The sensitivity increases rapidly at first and then more slowly, reaching a fairly stable state about seven days after the buffer has been added. In these experiments, the absorption measurements were made immediately after the solution had been irradiated. When we measured these solutions later, it was found that the readings had changed slightly, which was a surprise, as the unbuffered solution had not behaved in this way. The solution became slightly cloudy and showed the Tyndall effect, indicating the formation of colloidal particles. In a few days a definite precipitate had been produced. If this was left undisturbed when the solution was poured into the absorption chamber, the readings came back to the value obtained immediately after the exposure to x-rays.

<sup>2</sup>Leeds and Northrup: Notes on Hydrogen-ion Measurements, Notebook No. 3, 1930.

TABLE II.—CHANGE IN SENSITIVITY WITH AGE OF SOLUTION AFTER ADDITION OF BUFFER

Solution	1 67.5 per cent	Percentage	methylene 2	blue 3	changed 4	(in days)	8	11	25
A 1 hour		71.0	81.0	81.2	81.4	81.5			
A 1 hour		71.0				82.0			
A 30 min.	48.0	66.5	65.8	67.0	67.3	67.7			
B 1 hour	62.5	64.5				68.2	67.8		

A—Irradiated one hour inside chamber in dark glass tube.

B—Irradiated one hour, 50 cm. distance, 0.5 mm. copper, plus 1 mm. aluminum, filter.

The results of two series of measurements when the solution had been irradiated inside the "drum" are shown in Table III and Figure 1. All of the solutions of each one of these series had been irradiated the same day and the measurements were taken immediately after irradiation.

TABLE III.—RELATION BETWEEN THE LENGTH OF EXPOSURE OF THE SOLUTION TO X-RAYS AND PERCENTAGE CHANGE OF METHYLENE BLUE SOLUTION KEPT IN GLASS TUBES INSIDE THE X-RAY TUBE STAND DURING EXPOSURE

Time	Irradiated during Treatment	
	Percentage	decomposition
11.4 min.		20
26 min.		39
42.4 min.		54
1 hour, 22 min.		76
1 hour, 47 min.		83
Time	Continuous Radiation	
15 min.		25
30 min.		43
45 min.		55
1 hour		65
1 hour, 30 min.		78
2 hours		85
2 hours, 30 min.		90
3 hours		93

We used 0.0016 mg. methylene blue per cubic centimeter.

*F. Experiment with Superlawax.*—It is desirable to have the solution surrounded by nothing but organic material, and for that reason the glass tubes should be replaced. In the search for a suitable material for containers, certain celluloid products and other substances were tried. A small piece of the material was put in the solution in one glass tube and the change of the methylene blue produced by a dose of x-rays

compared to that taking place in another tube irradiated at the same time. It was found that kodaloid and cellophane reduced the effect on the methylene blue, whereas paraffin did not seem to have any disturbing influence. Paraffin ought to be a specially suitable material for the reason that cavities can be made in large blocks and filled with the solution; thus an arrangement simulating that used during treatment of a patient may be obtained. As we had some difficulty with the paraffin, particularly on account of the roughness of the surface, we substituted "superlawax" (another oil base), which seemed to work satisfactorily.

A groove 10 cm. long, 6 cm. wide, and 0.5 cm. deep was made in a block of superlawax. It was filled with a buffered solution with 0.0015 mg. methylene blue per cubic centimeter. A waxed paper was placed on top and sealed to the block with a little melted wax. The block was then placed under the x-ray tube and surrounded by paraffin so that the scattered radiation was fully utilized; 200 K.V., 30 ma., 0.5 mm. copper plus 1 mm. aluminum filter, 50 cm. S.T.D. was the technic. Under these conditions a rather intense erythema dose is obtained in 13 minutes. Table IV and Figure 2 give the results obtained from these experiments with solutions more than seven days old, measured immediately after the exposure.

Results with the solution irradiated in superlawax are not very satisfactory. The errors are too great and the problem of reducing them remains to be solved. The experimental values marked by dots and circles in the figure show a considerable spread and fall quite far away from the smooth curve

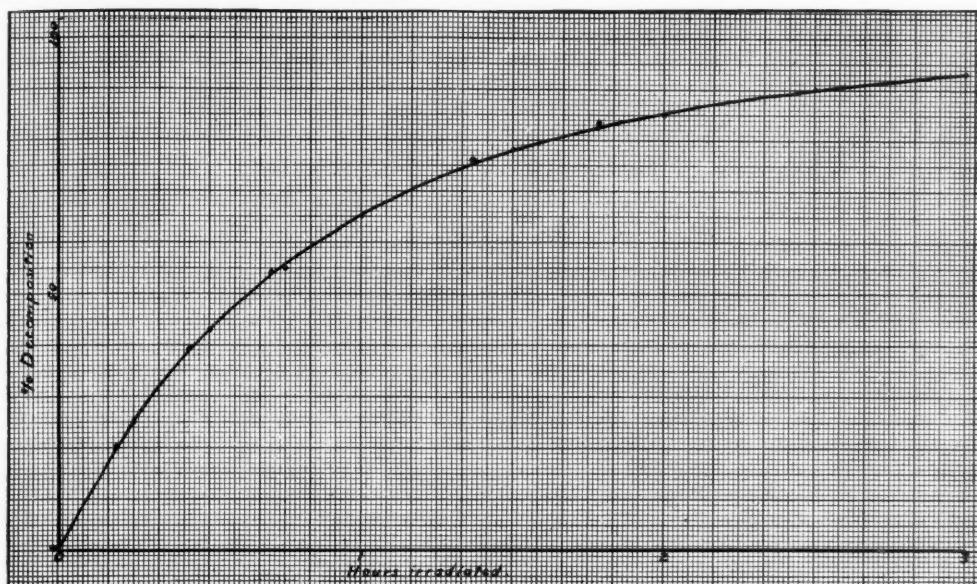


Fig. 1. Relation between the length of exposure (in glass) of the solution to x-rays and the percentage changes of methylene blue. Circles refer to first series of experiments; dots refer to second series of experiments.

TABLE IV.—RELATION BETWEEN THE LENGTH OF EXPOSURE OF THE SOLUTION TO X-RAYS AND PERCENTAGE CHANGE OF METHYLENE BLUE

Change in superlawax		
Time	Reading	Percentage decomposition
15 min.	10.7	54
15 min.	6.5	37.5
15 min.	6.0	40
30 min.	12.2	58
30 min.	12.1	58
30 min.	12.3	58
30 min.	11.0	55
45 min.	19.2	70.5
1 hour	20.6	72
1 hour	22.2	74
1 hour	23.0	75
1 hour, 15 min.	24.0	76.5
1 hour, 30 min.	24.0	76.5
1 hour, 30 min.	27.3	80.5
1 hour, 30 min.	26.4	79.5
1 hour, 45 min.	32.6	87
2 hours	34.5	89.5
2 hours	32.1	86.5
2 hours	32.0	86.5

drawn by inspection. The values obtained when the solution was sealed in glass tubes and irradiated inside the x-ray tube stand show much better agreement (Figs. 1 and 2).

The solution in the groove of the wax can

also be covered with paraffin and depth exposures made under a paraffin block. We made several such exposures at a depth of 5 centimeters. Naturally two or more solutions can be exposed at different depths simultaneously. The depth dose can be calculated from such a measurement with the help of Figure 2. One hour's exposure at a depth of 5 cm. gave a photometer reading of 16, which corresponds to an exposure of 38 minutes at the surface according to the curve. The depth dose at 5 cm., therefore,

$$\frac{38 \times 100}{60} = 63 \text{ per cent.}$$

*G. Small Containers.*—Sometimes it would be advantageous to have small containers with rather thin walls. Glass has usually been used, but the absorption and scattering from the glass contribute to the errors; it would, therefore, be preferable to replace it by organic material, if possible. Such substances as kodaloid and cellophane could easily be made into containers of suit-

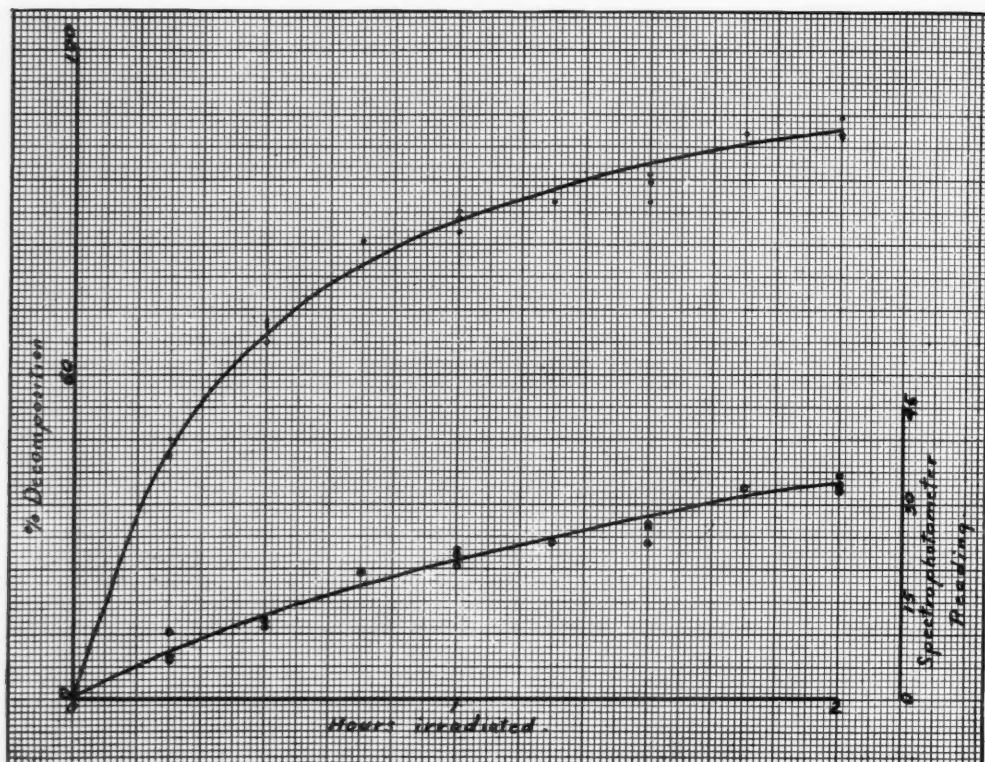


Fig. 2. Relation between the length of exposure of the solution to x-rays in superlawax and percentage change of methylene blue (marked by dots). The photometer reading is marked by circles.

able size and shape, but they were not considered, as our previous tests indicated that they influenced the change of the methylene blue. Whether this effect was due to the kodaloid and cellophane themselves, or some absorbed impurities, we cannot state for certain, but the effect was there, in spite of the fact that the material was carefully cleaned beforehand. Paralodien is another substance which seemed to offer possibilities. It was dissolved in a mixture of 50 per cent ether and alcohol and the inside walls of some of our original glass tubes were coated with this sticky solution. After the ether and alcohol had evaporated the tubes were washed with cleaning solution and distilled water. The methylene blue was then poured in and exposed to x-rays. The first experiment showed that the change in

the methylene blue was reduced, but further tests showed that the influence on the solution became less marked and disappeared altogether after the tubes had been standing for 15 days and had been cleaned very thoroughly. The effect probably was due to minute amounts of alcohol and ether. It, therefore, seems that paralodien can be used for containers in which the solution can be sealed and exposed to x-rays or  $\gamma$ -rays.

It has been mentioned that the exposure of the methylene blue solution to the amount of radiation corresponding to an erythema dose produces a decided change. It can now be measured with an accuracy of about 10 per cent. A slight increase in the sensitivity would make the method suitable for measuring fractions of an erythema dose. Containers could then be placed in cavities in

the patients during treatments and the dose obtained at different locations would be determined. We now need about twenty-five cubic centimeters of solution for measurements, but it seems probable that the amount can be cut down to about two cubic centimeters. Sievert (3) has recently proposed that small ionization chambers, with a charged condenser, might be placed in the tissues during exposure of the patient and the distribution of radiation measured in that way. Possibly solutions could be used in a corresponding way.

*H. Comparison with the Ionization Method.*—The measurements reported here must be considered as very preliminary. We wanted to point out the use that may be made of such measurements, and, as similar investigations may be under way at other laboratories, we believe it is of advantage to call attention to the pitfalls which have to be avoided.

The ionization method has been studied rather thoroughly. It is very valuable for measurements of radiation and is particularly suited for maintaining a primary standard. During the last year, Taylor (5) has shown how accurately measurements may be repeated with a standard air chamber and how well they may be reproduced with other chambers constructed in accord with the essential specifications. The standard air chambers give us information about the intensity of the radiation in a narrow beam of rays passing directly from the target through the diaphragms into the chamber. Rays coming from other portions of the tube and other objects are carefully avoided. These chambers, therefore, are not designed to give the average radiation intensity at a certain area of the skin during treatments. Other types of ionization chambers have been constructed for this purpose, which have also been very useful, but it is as yet a question of how accurately they register the dose given to the tissues. Certainly, in order to be reliable, they must be

handled with particular care and nobody without a considerable amount of training can obtain satisfactory results with them. Aqueous solutions of substances such as methylene blue can unquestionably be used to reproduce the treatment conditions very closely. They can be sent out to the different roentgen clinics for irradiation and be returned to the central laboratory for the measurements. The spectrophotometric measurements referred to in this article are very simple to perform after the apparatus is installed. Standardizations carried out in this way should be inexpensive after the method once has been perfected and checked against the standard air chamber. All machines could, therefore, be standardized as often as desired, perhaps every month, and there would be little excuse for not knowing the exact output from the x-ray tube used for treatments.

Another possibility is to expose at the same time solutions placed at several depths (for instance, 5 and 10 cm.) and to use these depth measurements as an indication of the penetrability of the rays. This would not give us a physically satisfactory definition of the rays, but it would, after all, give us the information which is of the most value for the treatments. As yet we have not obtained satisfactory agreement between the measurements made with the solution exposed in superlawax, although the values obtained when the solution was exposed in glass tubes are quite satisfactory. It seems, therefore, probable that this method could be used for comparison of dosages when the hardnesses of the rays do not differ appreciably. We should prefer to see the superlawax containers used for such comparisons, but this cannot be done unless the factor responsible for the fluctuations can be removed.

The investigations have to be continued and a number of questions have to be answered experimentally before it can be decided if such a method as is discussed here

can be made practical for the determination of dosage.

#### BIBLIOGRAPHY

1. CLARK, G. L., and FITCH, K. R.: Chemical Effects of X-rays upon Some Aromatic Colors and Dyes. *RADIOLOGY*, August, 1931, XVII, 285-293.
2. CLARK, W. MANSFIELD: Determinations of Hydrogen Ions. Williams & Wilkins Co., Baltimore, 1928, 3d edition, p. 203.
3. SIEVERT, ROLF W.: A New Method for Determining the Intensity of  $\gamma$ - and X-ray Radiation (Preliminary Results). *Acta Radiol.*, 1931, XII, 190-198.
4. STENSTROM, WILHELM, and LOHMANN, ANNE: Color Changes Produced by Roentgen Rays in Some Aqueous Solutions. *RADIOLOGY*, March, 1931, XVI, 322-327.
5. TAYLOR, L. S.: X-ray Protection. *RADIOLOGY*, September, 1931, XVII, 542-558.

#### DISCUSSION

DR. LAURISTON S. TAYLOR (Washington, D. C.): There is one point that I do not believe Dr. Stenstrom has brought out, yet which is of extreme importance in the application of a method of this kind to fundamental problems in the investigation of the distribution of energy beneath the surface of the body, or beneath the surface of a water phantom.

This solution that he mentions has very nearly the same effective atomic number as water or body tissue, and, therefore, absorbs the x-radiation to the same extent. One of the very great difficulties in understanding the problem of dosage is brought about by a few apparently arbitrary definitions that we are using: the first is the roentgen itself, and the second is depth dosage.

In the end it may be that this arbitrariness is not of importance. In the meantime what we want to know is how much radiant energy is absorbed at a given point in the medium. If, for example, you wish to determine the energy absorption per cubic centimeter of body tissue or water underneath the surface of the water phantom, you can not get it exactly by a direct ionization thimble chamber. You may be able to obtain it very indirectly. The advantage of Dr. Stenstrom's method is that if the chemical reaction which he reported is in proportion to the energy absorbed, you

may put into the water phantom one cubic centimeter of this methylene blue without disturbing the absorption of the medium as a whole. If you put such a cubic centimeter of dye beneath the surface of the water phantom, it is going to absorb the direct and scattered radiation in exactly the same manner as that of the other material in the same place.

So it gives us a very direct measure of the actual energy absorption at a particular point. That is fundamental in understanding the problem of depth dosage and its relationship to the biologic effect.

DR. R. R. NEWELL (San Francisco): Too much emphasis cannot be put on methods which enable us to study the distribution of absorption of x-ray energy in the tissue or in the phantom without introducing a disturbing substance. If you put in a bubble of air it disturbs the distribution in the ionization chamber. If you put in anything else, it disturbs the distribution, but, presumably, if we can introduce an organic substance which will respond, we can get the response without disturbing the distribution.

DR. STENSTROM (closing): I wish to emphasize again that these are only preliminary measurements and, therefore, we can not state as yet exactly what may be expected. There are many problems that have to be solved before this method can be made practical. For instance, we have to determine if the change in the methylene blue corresponds to the biologic reaction, and if it is proportional to the ionization in the ionization chamber, and a number of other problems. All of these have to be solved before such a method as this can become practical.

We are not stating that methylene blue is the best to use, though it is the best of the substances we have tried. This is just to open a way for investigations of this type. If we can find something that is better than methylene blue, it certainly will be of great value. I think, when we eventually get a chemical method for measurements of dosage, we will be very much better off than we are now.

## VALUE OF THE FUNCTIONAL GALL-BLADDER (IODEIKON) TEST, AS CHECKED BY OPERATIVE FINDINGS IN 70 CASES<sup>1</sup>

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**I**N 1925 at the Annual Meeting of the Manitoba Medical Association in Winnipeg, the author showed a number of X-ray films demonstrating a new method of investigating the gall bladder—the functional method first described by Graham and Cole. Since that time we have used the test in 650 cases, and have reached some very definite conclusions as to its value.

At the onset it should be stated that the iodikon test does not eliminate the other method of gall-bladder examination. It is supplementary to the barium meal and other clinical methods. It is used only if the history and other findings point to gall-bladder disease.

The iodikon test is based on the selectivity of the liver for the dye, tetraiodophenolphthalein, which is given orally or intravenously. It is excreted by the liver, and concentrated by the gall bladder in just the same way as bile is excreted by the liver, concentrated by the gall bladder, and stored there for use against the next meal. The test really involves the functional integrity of the liver cells, the bile radicles, the bile ducts, and the gall bladder. In cases of jaundice, the test will not differentiate between liver disease and gall-bladder disease. In practically all other conditions, the diagnosis lies at the gall-bladder end of the tract; here the test is of great value.

### TECHNIC

Following a mild laxative the night before and an evening meal sparse in fats, the dye is given (we prefer by mouth). Immediately before being swallowed 45 gr. are dissolved in distilled water and diluted with

a small bottle of grape juice. It is essential that the dye be fresh, and that it be freshly prepared immediately before each administration. No breakfast is taken the following morning. The first film is made 12 hours after the dye is given; and a second, at 18 hours. Then a meal rich in fats is given (the first food since the dye was ingested), a third film being made one hour after the meal. The first and second films should show the gall bladder filled with the well concentrated dye. The film taken after the meal should show the gall bladder to be reduced about half in size.

We gave the dye in capsule form to the first 215 cases in which we used this test, finding no gall-bladder shadow in 73 cases—34 per cent. But there was considerable difficulty in securing uniform absorption of the dye. Frequently we saw the undissolved capsules in the intestinal tract. In the last 435 cases, we used the dye in the original form, iodikon, finding no gall-bladder shadow in 123 cases—28 per cent, or an improvement of 6 per cent.

Out of this last series of tests, 70 cases which came to operation have been selected for study. They have been classified as:

No gall-bladder shadow.

Gall bladder filled and emptied normally.

Gall bladder was slow in visualizing and did not show on first or second films.

Gall bladder did not empty partly at the post-meal film.

Gall bladder filled and emptied normally, but was small or large.

Gall bladder filled and emptied normally, but was deformed.

Gall bladder filled and emptied normally, but shadow was faint.

<sup>1</sup>A clinical presentation before the Annual Meeting of the Manitoba Medical Association, at Brandon, Sept. 9, 1931.

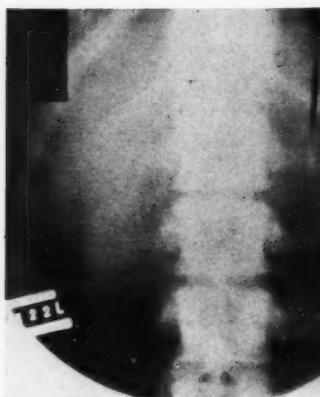


Fig. 1. A 12-hour film of Case 1.



Fig. 2. A 12-hour film of Case 2.



Fig. 3. A 12-hour film of Case 3.

The operative findings are classified as:

Large or small	Deformed
Thickened	Glands
Adhesions	Changes in color.
Stones	

Tables I through V classify the cases in groups according to the iodine findings, and indicate the operative findings, (1) for each individual case and (2) for each group.

Table VI summarizes Tables I through V, indicating the relative importance of the iodine findings as determined at operation.

#### SUMMARY

As a result of this analysis we draw the following conclusions:

1. As a test of gall-bladder disease, a positive finding (1 to 5) (iodine abnormality) was correct in 95 per cent of the cases. Of 54 abnormal cases, 51 showed disease at operation. (See Table VI.)

2. As a test of gall-bladder disease, a negative finding (6) (iodine normal) has no value. Of 16 normal cases, 13 showed disease at operation. (See Table II.)

3. As a test of gall-bladder function, the iodine test is of the greatest value. Of the 64 diseased gall bladders found at operation, the test showed 23 functioning normally; 15 functioned in a diminished way,

while 26 showed no evidence of functional activity. This should be of great value in determining the question of operation.

4. As an indication of the degree of gall-bladder disease, the most important abnormalities are: no shadow, delay, and deformity, since they occur more frequently and have the greatest average number of lesions per case (3). Of lesser importance are faint shadow and change in size of the shadow, since they have fewer average lesions per case (2). (See Table VI.)

5. As an aid in visualizing gallstones, the iodine method has been a disappointment. Usually the dye obliterates the shadow of a stone which is shown on a plain film. But gallstones are an end-product of gall-bladder disease, and diagnosis, before the stone-forming stage, is needed.

Five illustrative case reports are appended.

*Iodine Findings.*—Figure 1 is a 12-hour film of Case 1 in which the gall-bladder shadow was faint. At 18 hours, this shadow was much denser. There was deficiency in the concentrating power of the gall bladder.

*Operative Findings.*—The gall bladder, which was pale blue with enlarged glands about the neck, was removed.

*Iodine Findings.*—Figure 2 is a 12-hour film of Case 2. The gall bladder filled and

TABLE I.—IODEIKON FINDINGS. NO GALL-BLADDER SHADOW—28 CASES—  
OPERATIVE FINDINGS

Large size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
Yes	Yes		Yes			
Yes	Yes	Yes	Yes		Yes	
		Yes	Yes			Whitish-green
		Yes	Yes			Dark
Yes	Yes	Yes	Yes			Gray-green
		Yes	Yes			White
Narrow	Yes	Yes	Yes			
Narrow	Yes	Yes	Yes			
Yes	Yes	Yes	Yes			
		Yes				Gray
		Yes				Gray-green
Yes		Yes				Gray-green
		Yes				Gray-green
		Yes				
Yes	Yes	Yes	Yes	Yes		
Yes	Yes	Yes	Yes	Yes		White
		Yes	Yes	Yes		
		Yes	Yes	Yes		Red
		Yes	Yes	Yes		White
Yes	Yes	Yes	Yes	Yes		
Small		Yes	Yes			White
Yes		Yes	Yes			Gray
Normal gall bladder		Yes	Yes			Gray
Normal gall bladder						
Normal gall bladder						
	9	11	19	14	4	2
					Total	14
						73

*Note.*—Of the three normal gall bladders which did not show a shadow, one was removed by the surgeons, so we must question its normalcy. This leaves an error of 2 in 28, 7 per cent, a good result for a mechanical test.

TABLE II.—IODEIKON FINDINGS. GALL BLADDER FILLED AND EMPTIED NORMALLY—16 CASES—OPERATIVE FINDINGS

Large size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
Yes						
Yes					Yes	
Normal gall bladder						Gray-white
Yes						Gray-green
		Yes	Yes			Green
		Yes	Yes			Blue-gray
		Yes	Yes			Green
Yes	Yes	Yes	Yes		Yes	
					Yes	Gray-green
					Yes	White (fat)
					Yes	Pale blue
Small	Yes	Yes	Yes	Yes	Yes	Gray (fat)
Normal gall bladder	Yes	Yes	Yes	Yes	Yes	Gray-green
Normal gall bladder						Gray-green
	4	2	6	3	1	4
					Total	10
						30

emptied normally, but the neck and upper part of the fundus were unfilled, indicating adhesions.

*Operative Findings.*—The gall bladder, which was grayish-green, large, and ad-

herent throughout its length to the greater omentum, was removed.

*Iodeikon Findings.*—Figure 3 is a 12-hour film of Case 3. The gall bladder filled and emptied normally, but was small and narrow.

TABLE III.—IODEIKON FINDINGS. FILLING OR EMPTYING DELAYED, WITH OR WITHOUT DEFORMITY—9 CASES—OPERATIVE FINDINGS

In 6 cases gall bladder did not visualize until one hour after food.  
In 3 cases gall bladder did not empty at one hour after food.

## 6 Cases of Delayed Filling

Large size Small	Thickened Yes	Adhesions Yes	Stones Yes	Deformed Yes	Glands	Color changes White
						Gray-red
Yes	Yes	Yes	Yes	Yes		
3 Cases of Delayed Emptying						
Yes Yes (pouch)	Yes Yes	Yes	Yes	Yes Yes		Gray-white
4	4	4	6	6	Total .....	27

TABLE IV.—IODEIKON FINDINGS. GALL BLADDER FILLED AND EMPTIED NORMALLY, BUT WAS SMALL OR LARGE—5 CASES

Large size Small Small Large Large Normal gall bladder	Thickened Yes	Adhesions Yes	Stones Yes	Deformed Yes	Glands	Color changes White
						White
1	1	1	1	2	Total .....	4
						11

TABLE V.—OPERATIVE FINDINGS

(A) Gall bladder filled and emptied normally, but was deformed—6 cases.

Long	Size	Thickened Yes Yes Yes Yes Yes	Adhesions Yes Yes Yes Yes Yes	Stones Yes Yes Yes Yes Yes	Deformed Yes Yes Yes Yes Yes	Glands Yes Yes	Color changes (Fat) Gray (fat) Gray-green	
1			6		6	2	3	18

(B) Gall bladder filled and emptied normally, but the shadow was faint—6 cases.

Large		Yes Yes Yes Yes Yes		Yes	Yes		White Gray-green White	
1			5		1	1	3	11

*Operative Findings.*—The gall bladder, which was grayish in color and small, but free, was removed.

*Iodeikon Findings.*—Figure 4 is an 18-hour film of Case 4. It shows a small deformed gall bladder lying below a large



Fig. 4. An 18-hour film of Case 4.

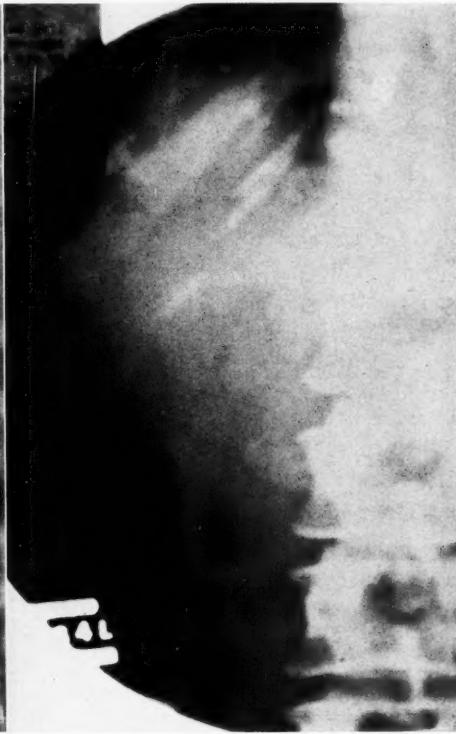


Fig. 5. Film of Case 5, made one hour after the fatty meal.

calcified cyst. The gall bladder filled and emptied normally.

*Operative Findings.*—The gall bladder was adherent throughout its length to the greater omentum. The right lobe of the liver was displaced by a large, irregular, inoperable cyst, which was calcified and palpated like a shell. The gall bladder was removed.

*Iodeikon Findings.*—Figure 5 is a film of Case 5, taken one hour after the fatty meal

was given. The 12-hour film did not show the gall bladder. The 18-hour film showed the gall bladder with the negative stones outlined by the small amount of dye which had entered. Figure 5 shows that the gall bladder is not emptying. It lies to the right of the fourth lumbar vertebra.

This patient was not operated on. It is one of the rare cases in which the iodeikon showed the negative gall stones.

TABLE VI.—VALUE OF IODEIKON TEST AS CHECKED BY OPERATION

Findings (iodeikon)	Findings (operative)		
	Diseased	Lesions found	Average lesions in each case
1. No shadow	28 cases	26	3
2. Delay	9 cases	9	3
3. Deformed	6 cases	6	3
4. Faint shadow	6 cases	6	2
5. Small or large	5 cases	4	2
	54 cases	51	
6. Normal	16 cases	13	2

## EFFECT OF IRRADIATION ON THE OVARY OF THE STRIPED GOPHER

(*Spermophiles citellus tridecemlineatus*)<sup>1</sup>

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**I**N 1919, Drips (1) called attention to the seasonal predominance of certain structures in the ovary of the striped gopher (*Spermophiles citellus tridecemlineatus*). The spermophile has one annual period of rut which immediately follows hibernation. At this time the ovaries are filled with numerous mature graafian follicles, together with a proportion of early or immature follicles. With fecundation, the corpora lutea develop enormously and are the predominating structures within the organ; in addition, usually there is only a framework of the ovarian stroma and a few atretic follicles. Degeneration of the corpora lutea begins in the late summer, and during the autumn the primary follicles grow rapidly to the stage of fully mature graafian follicles. In view of the constancy of these seasonal variations, it occurred to me that this species of animal might be particularly suitable for the study of the effects of irradiation on the various structures in the ovary, particularly in determining whether stimulation or inhibition of growth of any of its elements could be obtained with irradiation of less intensity than that which would prove destructive.

The animals for study were obtained shortly before they were to be irradiated, for although the striped gopher can survive long periods of captivity one cannot be certain that normal physiologic conditions prevail under such altered conditions of life. They rarely will breed in the laboratory (2).

Groups of gophers were irradiated at various times during the spring and summer months. Except in a few instances when

both ovaries were irradiated, the left ovary only was exposed to the rays. The abdomen was opened under ether anesthesia, the left ovarian pedicle was freed, and the ovary lifted out of the abdominal cavity. Protection was then applied to the entire body of the animal except the exposed ovary and a small portion of the ovarian pedicle. Ether anesthesia was maintained during irradiation to keep the animal from moving, which would disturb the protection and the position of the exposed ovary, and for the subsequent replacement of the ovary and closure of the abdominal incision.

A comparison of the two ovaries after this method of irradiation seemed to offer the best means of determining alterations due to irradiation alone, as well as of establishing for each animal the normal seasonal development at whatever time the ovaries were removed. Whether changes noted in the left ovary can be attributed only to irradiation or whether trauma of exposure and drying of tissue during irradiation is likewise a factor is not known. The frequency of unexplained degenerative changes in the ovary has been repeatedly emphasized. I studied serial sections of a number of ovaries of gophers killed shortly after they were captured besides the non-irradiated right ovaries of the experimental gophers in order to be thoroughly familiar with the normally occurring variations.

A Kelley-Koett moderate voltage roentgen-ray unit with a mechanical transformer and a Coolidge broad focus tube were used for the production of the roentgen rays. The peak voltage was maintained at 100 kilovolts, as measured by a standard sphere gap, with 5 milliamperes of current, and 1

<sup>1</sup>Work done in the Division of Experimental Surgery and Pathology, The Mayo Foundation. Submitted for publication July 2, 1932.

millimeter of aluminum inserted as a filter. The distance from the target of the tube to the surface of the exposed ovary was 9 inches. The time of exposure was varied as indicated in the different series of experiments. Under the conditions stated, the output of rays from our apparatus as measured in air with a Victoreen dosimeter was 71 r per minute. Because of the extremely small field or block of tissue exposed, correction factors for the effect of scattered rays or secondary rays from the lead-impregnated rubber used in protecting the remainder of the body were not obtainable.

The animals were killed at varying periods after irradiation. Both ovaries were placed at once in Zenker's fixative solution and were later embedded in paraffin and sectioned serially. The hematoxylin and eosin stain was used.

Five series of experiments were conducted in which the conditions of irradiation were identical except for the duration of exposures, which were three, five, ten, fifteen, and thirty minutes for each series, respectively.

*Series 1.*—The left ovary of six gophers was irradiated in the early Summer of 1931 with a three-minute exposure (intensity 213 r). These animals were killed twenty-four hours and four, seven, thirteen, twenty, and fifty-eight days after irradiation, respectively. In only one experiment was there a distinct difference in the irradiated and non-irradiated ovaries. Although many young healthy follicles were present in the left ovary the number was greatly reduced in comparison with the right ovary, and there was a corresponding increase in remnants of degenerated follicles. It is unlikely that this difference can be attributed to the effects of irradiation inasmuch as in the second series of animals in which the left ovary was exposed to irradiation for five minutes, noteworthy difference was constantly absent in irradiated and control ovaries.

*Series 2.*—The left ovary of ten gophers

was exposed to irradiation for five minutes (intensity 355 r). The animals were killed at varying intervals of from one to sixty-five days after irradiation, respectively; comparison of the right and left ovaries failed to establish any recognizable alteration resulting from the irradiation. The number and size of the developing follicles were strictly comparable in both ovaries and were normal for the corresponding seasonal development for the species. The corpora lutea and ovarian stroma were entirely unaffected by irradiation, not only in these series but also in all the later experiments in which more intensive irradiation was applied.

*Series 3.*—The left ovary of eleven gophers was exposed to irradiation for ten minutes (intensity 710 r). The animals were killed at varying periods from the second to the one hundred twenty-ninth day after irradiation, respectively. No effect of the irradiation was noted in the animals killed on the second, third, fourth, and seventh days after irradiation; there was, however, a marked difference in the ovaries of a gopher killed on the twelfth day. The right ovary was in a stage of active follicular development, the cortical rim being crowded with primary follicles and primordial cells, interspersed with intermediate and many maturing follicles. The left ovary exhibited generalized follicular degeneration of apparently rather recent origin, as the structural identity of the cells had not been lost, although the cell borders were indistinct, and the nuclei were absent or pyknotic. In some of the larger follicles there was partial fusion of the follicular contents into the characteristic eosinophilic amorphous mass which marks the old atretic follicle; in others, the zona pellucida of the ova cell was markedly thickened and deeply stained. However, primary follicles and primordial cells remained which, although rather poorly stained, had normal nuclei and an evenly granular protoplasm. A similar picture was

presented in the case of the gopher killed on the seventeenth day after irradiation, with slightly more advanced degenerative changes in the follicles of the left ovary.

Both ovaries of two gophers killed on the twenty-fifth day after irradiation had been exposed to the roentgen rays. The ovaries were found to be much smaller than normal, and on microscopic study the stroma was very dense. Most of the follicles had been destroyed, only a few primordial and intermediate follicles persisting apparently uninjured. A few graafian follicles with slight stigmas of degeneration were found in one ovary. The amorphous eosinophilic masses representative of follicular atresia were greatly increased as compared with sections of non-irradiated ovaries. At times, these masses were still surrounded by an irregular corona of epithelial cells and in a few instances cystic spaces partially filled with amorphous débris and recognizable clumps of chromatin indicated an earlier stage in the process of fusion and atrophy. Corpora lutea were present in the usual stage of involution found at this season in the normal animal. The ovaries of all animals examined subsequently in this series corresponded closely to these two.

*Series 4.*—The left ovary of twenty-one gophers was exposed to irradiation for fifteen minutes (intensity 1,065 r). The animals were killed from the third to the one hundred tenth day after irradiation, respectively. On the third and sixth day after irradiation, no noticeable change in the irradiated ovary was detected, but in the animal killed on the tenth day, the left ovary, in contrast to the right, did not exhibit large graafian follicles and the primary and small intermediate follicles exhibited definite stigmas of degeneration such as ova with pyknotic nuclei, and fragmented cytoplasm and disorganized follicular structure. No healthy or intact follicles were found in this ovary, although a few primordial cells at the periphery of the ovary appeared to be struc-

turally intact. Similar follicular destruction in the irradiated ovary, with the invariable persistence of a few intact primordial cells or occasional primary or intermediate follicles were found throughout the series from the tenth day after irradiation. A few ovaries contained a larger proportion of surviving follicles and in two animals a few graafian follicles were found as well as the more immature forms, indicating a variation in the susceptibility of individual animals of the same species as well as an obvious difference in vulnerability of the individual follicles. The irradiated ovary of the animals killed at the longer intervals after irradiation was extremely small as compared with the control ovary; the stroma was very dense, although not definitely changed in cellular constituents. There was a slight tendency for persistent thecal cells to arrange themselves in irregular circular formations following the destruction of the epithelial constituents of the follicle. This gave rise to an appearance of cord-like masses or follicles without ova, but was not sufficiently marked in any ovary to be regarded as a characteristic formation of the thecal cells in the irradiated ovary. In no instance was there any evidence of proliferative changes of the stroma or follicular remnants. Throughout the series of experiments the corpora lutea failed to show any effect from the irradiation, directly or as a result of the follicular atrophy. The regression of the corpora lutea continued throughout the summer months as in the normal animal not living in captivity.

To note particularly whether the few surviving primary follicles seen in all the irradiated ovaries were capable of late development, the left ovary of four other gophers was irradiated for fifteen minutes (intensity 1,065 r) in August, 1931, and the animals were killed in April, 1932. In three experiments infection of the abdominal wound occurred, and resulted in partial destruction of the left ovary. In the fourth experiment

the abdominal incision was well healed and the left ovary, although extremely small, was easily identified. The right ovary in this animal was at least six times the size of the left ovary, but was somewhat small in comparison with the normal ovary of the animal captured at this season of the year. Cross-sections of the right ovary disclosed many graafian follicles; a rather high percentage of them disclosed some degenerative stigmas. There were numerous primary and small intermediate follicles and a small percentage of old atretic follicles. The ovary contained two or three small primary follicles in which the cell nucleus of the ova was well preserved, but the cytoplasm was stained irregularly. There were no distinct follicles without ova or any evidence of regenerative or proliferative changes.

*Series 5.*—The left ovary of six gophers was exposed to irradiation for thirty minutes (intensity 2,130 r). One animal died from injury within twenty hours after the irradiation and the ovaries were removed shortly afterward. The others were killed in series on the sixth, twentieth, thirty-fourth, and forty-fourth day after irradiation, respectively. No difference could be found in the right and left ovaries removed on the first and sixth days. The fact that in the left ovary of the second animal there were no large graafian follicles is of relatively little significance, as such variation in development of follicles is frequently found at this particular season of the year. One animal was found dead in its cage on the morning of the ninth day after irradiation, and, although postmortem changes had occurred by the time the ovaries were removed, the ovarian pedicle and the ovaries appeared normal grossly, although the adjacent tubes were discolored. On microscopic examination a high proportion of degenerated follicles was noted in both ovaries, most of which were in an intermediate stage of development. The majority of the small and primary follicles appeared uninjured, as did cer-

tain of those of intermediate size. In this instance the left ovary contained more large follicles than did the right ovary, a variation in development to which especial significance cannot be given. Both ovaries were congested with blood, and cross-sections of blood vessels exhibited a high percentage of polymorphonuclear leukocytes, indicating an inflammatory reaction. Of the three remaining gophers killed on the twentieth, thirty-fourth, and forty-fourth day after irradiation, respectively, the right ovary in each was free from infection, and exhibited normal seasonal development of follicles, whereas the left ovaries had undergone almost total follicular atrophy, with a few small follicles persisting in each. The left ovaries were small, the stroma being very dense and containing amorphous or hyalinized remnants of degenerated follicles. Corpora lutea were present in normal stages of involution. Thecal cells were irregularly distributed in the periphery of these ovaries, and whorl-like arrangements suggestive of follicles without ova were only slightly manifest. The blood vessels in the left ovaries had apparently been unaffected by the irradiation.

#### CONCLUSIONS

1. Direct irradiation applied to the ovaries of the striped gopher in intensities of 213 and 355 r failed to produce any recognizable injury to the follicular stroma or alteration in their later growth and development. With intensity of 710 r destruction of almost all of the follicles occurred. Degenerative changes were first noted after a twelve-day interval following irradiation. Many primary follicles and primordial cells survived this irradiation and in a few instances, after a longer interval mature graafian follicles were found, all of which, however, showed some slight stigma of degeneration. Irradiation of an intensity of 1,065 r produced massive follicular destruction noted first on the tenth day after irra-

diation and apparently affecting first the larger follicles. In all the irradiated ovaries a few primary follicles had survived, but in no instance even with observation eight months after irradiation and in the spring of the year, when the impetus to follicular development seems most marked, had these follicles exhibited the usual development. Irradiation with an intensity of 2,130 r resulted in massive follicular degeneration apparent on the ninth day after irradiation, but likewise with the survival of a few structurally intact primary follicles.

2. The corpora lutea, blood vessels, and

ovarian stroma were apparently unaffected by the irradiation.

3. No tendency toward proliferative change or formation of atypical cysts as noted in ovaries of the rat after irradiation was found in the irradiated ovaries of the gopher.

#### REFERENCES

- (1) DRIPS, DELLA G.: Studies on the Ovary of the Spermophile (*Spermophilus citellus tridecemlineatus*), with Special Reference to the Corpus Luteum. *Am. Jour. Anat.*, March, 1919, XXV, 117-183.
- (2) JOHNSON, G. E.: Early Life of the Thirteen-lined Ground Squirrel. *Trans. Kansas Acad. Sci.*, 1931, XXXIV, 282-290.

### THE ADVANTAGES OF THE X-RAY EXAMINATION OF THE CHEST IN LATERAL RECUMBENCY<sup>1</sup>

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**I**N this paper we are interested in the appearance of the upper hemithorax in a film made with the subject reclining on one side. We find the upper half of the chest large, the air content increased, while the normal airless structures and all abnormal deposits are brought out to better advantage than when films are made with the body in other postures.

#### PHYSIOLOGIC CONSIDERATIONS

In the standing and the sitting postures, the human chest is in relative collapse, even during deep inspiration. This perhaps unexpected phenomenon is due to the effect of gravity on the ribs and sternum, the weights of the shoulders and the chest viscera, as well as to the soft parts suspended from the diaphragm and ribs. These weights pull the ribs and sternum downwards, *i.e.*, they resist inspiration. Now, upon assuming the recumbent position, the chest is enlarged because the ribs and sternum rise, as they are relieved from the force of gravity (1).

Measurements of the circumference of the chest show that it increases in every case upon the subject's changing from the erect to the recumbent position (2). This increase in chest capacity results in increased air content of the lung. The vital capacity is diminished (3), and the residual air increased in the recumbent position (4); *i.e.*, the lungs are in relative emphysema in the recumbent position. This relative emphysema can be easily demonstrated by percussing over the liver and heart areas; the areas of dullness, invariably present in the erect posture in the normal individual, decrease or disappear when the subject lies on his back. Norris (5) finds that in the dorsal position the anterior margin of the lung moves downward, being about 2 cm. lower than in the erect posture.

On fluoroscopic examination, there is an increased transparency of the lungs in the recumbent position. In the obese or very muscular individual, in whom fluoroscopic examination is unsatisfactory in the erect position, we have learned to employ screen-

<sup>1</sup>Published with the permission of the Medical Director of the United States Veterans' Administration, who assumes no responsibility for the opinions expressed or the conclusions drawn by the writers.

ing in the recumbent position, as the results are found to be more satisfactory. Films made in this position also show the lungs as more transparent than when they are made in the erect posture. The following conditions, however, militate against the usefulness of roentgenograms made in the recumbent position:

1. The diaphragm rises high in the chest (6), compressing or relaxing the lungs.
2. The heart is enlarged in its transverse diameter (7), encroaching on the lung fields.
3. The sternum moves cephalad (8), and with it the clavicles, encroaching on the apical regions.

It is largely for these reasons that roentgenograms of the chest are routinely prepared in the erect position in spite of the increased radiability of the exposed portions of the lungs in the recumbent position. The objections mentioned do not apply, however, to films made in lateral recumbency.

In lateral decubitus, the circumference of the chest is smaller than in dorsal recumbency, due to the increased weight acting on the recumbent hemithorax; however, the hemithorax under consideration (the upper half of the chest) is larger than in the supine position. The difference in the two sides may be further increased by placing a pillow, or sand bag, under the lower side. Here is a typical measurement, taken at random from records made at our clinic:

Circumference of the chest at level of sixth costal cartilages in quiet inspiration:

Standing .....	89 centimeters
Lying on back.....	92 centimeters
Lying on left side.....	91 centimeters

(Upper half measuring 47, lower 44 centimeters)

With use of sand bag, circumference

is .....	89 centimeters
(Upper half measuring 47.5, lower	
41.5 centimeters)	

Upon inspection, the contraction of the lower side and the enlargement of the upper

side are plainly seen. Over the lower side the lung is compressed, as evidenced by dullness, increased conduction of breath and voice sounds (9), and by displacement of the heart to this side. Over the upper half, there are signs of emphysema in the form of hyperresonance and diminished breath and voice sounds. The diaphragm is pushed up on the lower side by the crowding of the abdominal viscera. On the upper side the subdiaphragmatic pressure sinks, due to the pulling away of the abdominal viscera, allowing the diaphragm to descend into an exaggerated inspiratory position. By means of percussion, Norris (10) finds that in lateral decubitus the edge of the lung on the upper side moves down for from 3 to 4 centimeters.

On roentgen examination, the recumbent lung appears relatively small and airless, while the upper lung is emphysematous. The inflation of the upper lung is favored by the shifting of the heart downward, and by the descent of the upper half of the diaphragm. But even in cases in which the heart and diaphragm are fixed by adhesions, the upper lung assumes increased transparency in lateral decubitus, due to enlargement of the bony thorax. It is believed that there also occurs a slight curvature of the dorsal spine, concavity downward, crowding the ribs in the lower hemithorax, and spreading them on the upper side. In this connection, it is recalled that, in the operation for suppurative pleurisy, surgeons have for generations placed their patients with the good side resting on a pillow, expecting thus to increase the intercostal spaces on the involved side.

#### PATHOLOGIC CONSIDERATIONS

All pathologic processes involving the lungs and pleura are generally associated with a certain degree of atelectasis, dependent upon occlusion of bronchi by secretion and other factors. Such areas of collapse

have been described in pneumonia, pleural effusions, emphysema, abscess of the lung, bronchiectasis, and even acute bronchitis (11). That atelectasis plays an important rôle in pneumonia and tuberculosis (12) is well recognized. Bartels (13) accepted it as a necessary state in the development of bronchopneumonia. More recently Coryllos and Birnbaum (14) have described, in a convincing manner, the etiologic importance of atelectasis in lobar pneumonia. Atelectasis has also been pointed out in cases of pericarditis with effusion, in hypertrophy and dilatation of the heart, and in enlargement of the mediastinal and hilar lymph nodes as observed in tuberculosis, Hodgkin's disease, leukemia (15), and aortic aneurysm (16).

These atelectatic areas, unless dependent on permanent bronchial occlusion, are likely to become inflated in the lateral horizontal position. For this reason, frequent changes in posture have been used in pneumonia, and especially in the prevention and treatment of hypostatic pneumonia and massive atelectasis. Time-honored methods of resuscitation of the newborn and of the drowned depend for their efficacy on the circumstance that rhythmic changes in posture connote a rhythmic expansion and contraction of the chest.

#### PRACTICAL APPLICATIONS

A roentgenogram made in lateral recumbency shows the upper lung expanded more than in any other posture. The pleural recesses, collapsed in other postures, are now largely inflated, and portions of the lungs usually obscured by the heart, hilum, mediastinum, and by the dome of the diaphragm, are brought into view. The atelectatic areas accompanying pathologic inflammatory or degenerative processes in the lungs and heart may become air-bearing. On films made in this position, the underlying pathologic process appears smaller, but better de-

fined. Abnormal deposits in the vicinity of the diaphragm or mediastinum, appearing of uncertain location when they are viewed on films made in the erect posture, may be plainly surrounded by lung tissue in lateral recumbency. Abscess cavities, small effusions, and hydropneumothoraces which, in the erect posture, may be obscured by atelectatic lung and thickened pleura, may become plainly visible with the increased air content of the horizontal position. Fluid levels which are obscured by collapsed lung, or due to the shallowness of the overlying air pocket, become conspicuous in lateral decubitus. Likewise lung tumors, which otherwise may be merely suspected, appear well defined on films made in this position. Also, air collections appear conspicuously enlarged. Air being more expandable than collapsed lung tissue, with the enlargement of the upper hemithorax, the former expands to occupy more space. Pleural effusions (without air), on the contrary, appear larger in the dependent hemithorax (17, 18) because they are less compressible than lung tissues.

#### CONCLUSIONS

1. With the subject lying on one side, the upper hemithorax is larger than in any other posture. The lung is emphysematous in this position, as shown by percussion, auscultation, and roentgen examination. The hyperinflation of the lung is due not only to the enlargement of the chest, but also to the shifting of the heart and diaphragm.

2. Roentgen examinations of the upper hemithorax show the lung larger and more transparent than it appears in other postures. Portions of the lung obscured by the diaphragm and by the mediastinum thus become visible and accessible to examination.

3. Most pathologic processes in the lungs are associated with bronchial occlusion and atelectasis. In films made in the erect pos-

ture, the chest being in relative collapse, the atelectatic areas frequently obscure the underlying causative pathology. Upon assuming the lateral position, the upper lung becomes inflated and many of the atelectatic areas re-expand, producing a truer picture of the disease process. Tumor masses, cavities, and fluid levels are also brought into better relief.

4. Pleural effusions appear larger in the recumbent hemithorax. If they are small, they may escape roentgenologic visualization except when they are viewed in this position.

#### REFERENCES

- (1) FELIX, W.: Anatomy of the Chest. Sauerbruch's Chirurgie der Brustorgane, second edition, Vol. I, p. 28.
- (2) KOROL, EPHRAIM: Etiology and Mechanics of Massive Atelectasis. *Am. Rev. Tuberc.*, September, 1931, XXIV, 276-284.
- (3) HUTCHINSON, J.: Article on Thorax in Todd's Encyclopedia of Anatomy and Physiology, 1849-1852, IV, 1067.
- (4) ROHRER, FRITZ: Beth's Handbuch der Normalen und pathologischen Physiologie, II, p. 85.
- (5) NORRIS and LANDIS: Diseases of the Chest. Fourth edition, p. 105.
- (6) HOLZKNECHT and HOFBAUER: Zur Physiologie und Pathologie der Atmung. I.—IX. Mitteilung aus dem Laboratorium für radiologische Diagnose, 1907, II.
- (7) MORITZ, F.: Regarding the Changes in Shape, Size, and Position of the Heart in Changing from the Horizontal to the Vertical Posture. *Ztschr. f. klin. Med.*, 1905.
- (8) BYLOFF, K.: Regarding the Position and Function of the Diaphragm. *Wiener klin. Wochenschr.*, July 31, 1913, XXVI, 1269.
- (9) ADAMS, R. D., and PILLSBURY, H. C.: Position and Activities of the Diaphragm as Affected by Changes of Posture. *Arch. Int. Med.*, February, 1922, XXIX, 245-252.
- (10) NORRIS and LANDIS: Diseases of the Chest. Fourth edition, p. 106.
- (11) DELAFIELD and PRUDEN: Text-book of Pathology. Eighth edition, p. 538.
- (12) KOROL, EPHRAIM: Atelectasis in Pulmonary Tuberculosis. *Am. Rev. Tuberc.*, May, 1931, XXIII, 493-506.
- (13) BARTELS: Observations on the Lung Lesions during an Epidemic of Measles. *Virchow's Arch.*, XXI, 386.
- (14) CORYLLOS, P. N., and BIRNBAUM, G. L.: Lobar Pneumonia Considered as Pneumococcal Lobar Atelectasis of Lung Bronchoscopy Investigation. *Arch. Surg.*, January (Part 2), 1929, XVIII, 190-241.
- (15) KOROL, E.: Studies of Atelectasis. U. S. Veterans' Bureau Med. Bull., January, 1931, VII, 10-20.
- (16) BRAMWELL, BYRON: Lung Lesions in Aortic Aneurysm. *Edinburgh Med. Jour.*, XVI, 106.
- (17) POLGAR, F.: Contribution to the Shifting Test of Pleural Effusions. *Fortschr. a. d. Geb. d. Röntgenstr.*, 1926, XXXV, 618.
- (18) HJELM, R., and LAUREL, H.: Displaceability of Pleural Exudates and Method of Roentgenologic Demonstration of Minimal Shifting Exudates. *Upsala läsaref. förh.*, Aug. 15, 1931, XXXVI, 305-312.
- (19) HOFBAUER, L.: Beth's Handbuch, II, 387, 388.

#### GASTRIC MOTILITY AS INFLUENCED BY PARALYSIS OF THE DIAPHRAGM<sup>1</sup>

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UNDER normal conditions the diaphragm produces definite changes to the cardia and the stomach, and is one of the important factors in controlling the opening and closure of the former. Thus, during respiratory contraction of the diaphragm the pillars also contract, and, by so doing, they produce a milking-down contraction at the cardia (1). This contraction can be felt by the examining finger in-

serted through a gastrostomy into the opening of the gastro-esophageal junction. The terminal phase of this contraction can be seen fluoroscopically (2). When a barium meal is given and the subject is studied in the oblique upright position, one can see at deep inspiration that the barium gathers just above the cardia in the esophagus, much like so-called cardiospasm (Fig. 1). This picture persists as long as the diaphragm remains contracted; just as soon as the diaphragm relaxes during the expiratory

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Fig. 1. Constriction of cardia from the pillars of the diaphragm. Note closure of cardia with filling of esophagus.

phase, the cardia also opens and the barium meal runs through into the stomach.

The peripheral portion of the diaphragm also has a definite influence on the stomach. When one watches the stomach which is filled with a barium meal, he will notice that as the diaphragm contracts and relaxes, it produces definite changes in the contour and the position of the different parts of the stomach (3). The fundus is pushed down and is definitely constricted with each downward contraction of the diaphragm. Coincident with this constriction and descensus of the fundus we can see a change in the shape of the pyloric portion of the stomach (Fig. 2). The changes in contour of the stomach remind one of the changes in the contour of an earthworm as it moves from one place to another. One sees a definite swelling of the forepart while the hind part moves forward and then the forepart becomes thinned out as it progresses. In this connection one may also be reminded of the

effect of pressure on a sausage-shaped rubber balloon in which, when one portion is squeezed the opposite portion is dilated. After a few deep breaths one can see characteristic peristaltic waves originating at the *incisura angularis*, waves which are noticeable when the stomach is left absolutely alone without any manipulation. One would suspect that the imparted contractions and dilatations of the stomach (originating by means of the contracting and relaxing diaphragm) may have something to do in stimulating gastric peristalsis, if he will analyze what happens when a person is made to swallow a stomach tube. The disagreeableness of this procedure induces nausea and vomiting. When, however, the subject is made to take deep breaths, the nausea disappears in most cases. A similar group of phenomena can be studied fluoroscopically. At times one has a patient who cannot tolerate a barium meal. It will be noticed under such circumstances that the stomach assumes an hourglass shape, the fundus becomes more dilated, and the pars pylorica more contracted. If, now, the patient is asked to take a few deep breaths, he will no longer complain of nausea, and fluoroscopically one can see a relaxation of the hourglass ring and sooner or later normal peristaltic waves become evident. Although it is folly to assume that the diaphragmatic contractions are entirely instrumental in inducing gastric peristalsis, it is perfectly justifiable to assume that the diaphragm plays an important rôle in the initiation and maintenance of gastric peristalsis.

Theoretically, when rhythmical constrictions and dilatations occur in the stomach, definite stimulative changes must of necessity follow in certain portions of the stomach. It is common knowledge that when a muscle contracts, a difference of electrical potential may result at the two ends. Moreover, it has been shown by Alvarez (4) that there is a gradient of rhythmicity

in the muscle of the stomach and that this gradient is greatest at the lesser curvature near the cardia, with the rate of eleven at the cardia to two at the pars pylorica. He says:

"We see that local peculiarities in the muscle, with graded differences in rhythmicity, irritability, tone, and latent period, probably have most to do with directing the peristaltic wave as it travels over the stomach. As in the heart, so here, the waves probably have their origins in the most highly rhythmic and sensitive area. We may say perhaps that the region on the lesser curvature next to the cardia is the pacemaker for the stomach. It must be remembered, however, that the cavities of the heart and stomach are very different. In one, the impulse travels so rapidly that the organ appears to contract as a unit; in the other, a series of waves travel slowly over the sac, gently kneading its contents."

McCrea, McSwiney, Morison, and Stopford (5) have also noticed in cats, rabbits, and dogs that the waves which began near the cardia, spread downward, producing a constriction ring at the upper end of the pars pylorica, then a bulging of the pyloric portion, and finally a concentric contraction ring of that region. This contraction, relaxed as a new wave, arrives at the incisura. These facts demonstrate that a wave initiated in the cardia and fundus is conducted down to the pars pylorica.

One must not lose sight of the fact that many other factors influence gastric motility. The work of Todd and his associates (6) has given us a clearer conception of many factors involved in gastric motility. Such factors as hunger, psychic shock, gastric training, central or peripheral impulses through the vagus or the parasympathetic, secretory activity either normal or pathologic, the application of heat or cold (7), and the quantity as well as the quality of food intake have a great deal to do in stimulating or inhibiting peristalsis. Again, one should remember the intrinsic qualities of

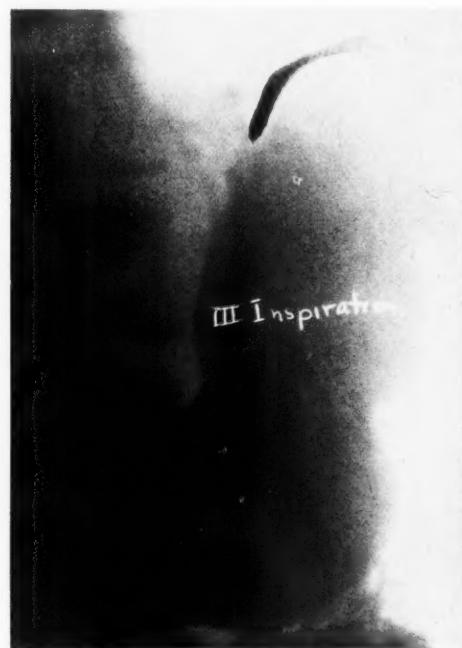


Fig. 2. Effect of diaphragmatic contraction on stomach. Note low position of fundus with relative constriction at fundus and dilatation at pars pylorica.

gastric muscle, namely, contractility, rhythmicity, and automaticity. Alvarez (4), for instance, has noticed evidence of high automaticity at the upper edge of the pars pylorica. He also describes contractions of a greater amplitude in the pars pylorica than in the fundus. With a cardia, therefore, that has a high gradient of rhythmicity, and which is made to open and close with each inspiration and expiration, what would stop action currents from travelling down towards the pars pylorica and initiate characteristic gastric peristalsis? Moreover, there are definite changes in intragastric tension in the different parts of the stomach during the inspiratory and expiratory phases of diaphragmatic motility. These without a doubt are also likely to produce a sufficient stimulation to aid in or initiate peristalsis.

The question may be asked by skeptics, Why, if the diaphragm controls basically the



Fig. 3. Effect of diaphragmatic relaxation on stomach. Note high position of fundus and relative constriction of pars pylorica.

gastric contractions, do we not get any clinical symptoms of gastric disturbance in patients with phrenicotomy or phrenic neurectomy? We hope to show in this paper that compensatory changes in gastric motility occur in such a way that normal contraction waves may still be initiated in spite of the paralysis of the diaphragm. Dr. S. J. Cohen (8) of the gastro-enterology staff of the Municipal Tuberculosis Sanatorium of the City of Chicago, who made secretory studies of these patients before and after phrenicotomy, found no gastric secretory changes resulting from the diaphragmatic paralysis. He says:

"In this series of cases the results of the Ewald meal correspond to those of 1,000 consecutive cases studied similarly at the Chicago Municipal Tuberculosis Sanatorium. In this group 45 per cent showed a hypo-acidity ranging from 6 to 19 per cent of hydrochloric acid. There was a normal secretion in 36 per cent of this group, with the gastric juice showing an acidity of 20 to 39 per cent. In 9 per cent

of this group there was a hyperacidity, while in the remaining 10 per cent there was an achylia gastrica. There was no variation, therefore, in the reaction to the Ewald meal before and after phrenicotomy."

#### OBSERVATIONS AND RESULTS

Forty patients from the Sanatorium have been studied. They were all ambulant cases and had had their phrenicotomy from one week to fourteen months previous to observation. A small number of women had a costal respiration throughout and the paralyzed diaphragm did not show any appreciable rise. Our results were fairly constant and depended entirely upon the side on which the paralysis was effected.

The following technic was carried out in all our observations: A concise history was taken, with specific questioning about possibility of gastro-intestinal trouble either before or after phrenicotomy. An Ewald meal was then given and the secretory activity was studied by Dr. S. J. Cohen. A fluoroscopic notation was made of the degree of rise of the diaphragm (9), the presence of normal or paradoxical mobility, and the degree of lung pathology still present. The patient was now placed in an oblique position with the left shoulder against the screen in the manner suggested by R. D. Carman (10). The barium was now followed down the esophagus and as soon as it reached the cardia the patient was asked to take a deep breath. After the tone of the cardia was studied the reaction of the stomach was noted as it was affected by the contractions of the healthy diaphragm. The patient was then placed in an anteroposterior position and the reaction of the fundus and the pars pylorica was noted. Permanent records of the stomach were obtained at deep inspiration and deep expiration, immediately after ingestion of the barium meal, after two hours and after twenty-four hours.

Our results have been quite constant.

They may be classified under three general headings, namely: (1) patients in whom respiration was of the costal type; (2) patients with left phrenicotomy, and (3) patients with right phrenicotomy. Some patients have been studied just before phrenicotomy, one week after operation, and from four to six weeks after operation.

The patients who had a distinctly costal respiration showed little or no rise in the diaphragm after phrenicotomy (Fig. 3). The normal diaphragm moved very slightly and only after an unusually deep breath. The paralyzed diaphragm at this instant moved slightly upward when the healthy diaphragm moved downwards. There was usually a poor pillar tone, so that the barium could not be held at the cardia. The stomach was of the long tubular type, with the pars pylorica located down in the pelvis. Very little transmitted constriction was noticed in the stomach during deep inspiration. In this type of patient a phrenicotomy would be hardly of any value because the altered mechanics produced by the paralysis of the diaphragm are not present and, therefore, the operation could not be of any significant benefit to the tuberculous lung.

In the second group we studied patients with left phrenicotomy, showing some paradoxical rise of the left diaphragm. Coincident with the descensus of the right diaphragm there was a rise of the left diaphragm. The pillar tone was fair and the barium remained at the cardia a few seconds during each inspiration. The mobility of the fundus was minimal and it remained usually well ballooned up with a bubble of air. Belching was difficult in these patients. The pars pylorica was seen to swing laterally and obliquely so that the movements reminded one of a pendulum with the fundus remaining stationary (Fig. 4). The degree of the altered motility in the stomach depended upon the tone of the right diaphragm. In addition to these lateral movements one also noticed a constriction at the

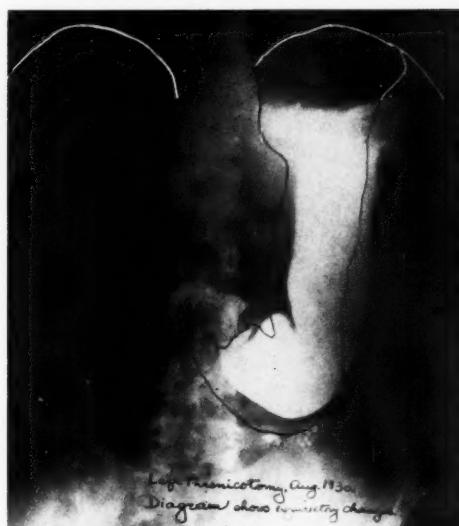


Fig. 4. Left phrenicotomy.

pars pylorica, with a definite dilatation of the parts immediately above it. The constriction wave progressed along a "U"-shaped line, one tip being at the pylorus and the other at the incisura.

In the third group of patients, in whom the right diaphragm was paralyzed, there was only a slight deviation from the normal imparted motility in the stomach. The tone in the cardia was normal and the fundus descended with each diaphragmatic contraction (Fig. 5). Coincident with this there was a dilatation of the pars pylorica. Because of the rise of the right diaphragm the angle at the cardia became more obtuse, so that, during an attack of coughing, the cardia would open and cause regurgitation of gastric contents. This phenomenon was verified clinically in that these patients complained of a tendency to vomiting during attacks of coughing. This altered angle at the cardia also made the tendency to belching much easier. Under normal conditions (11) when the patient is asked to belch we can notice the left diaphragm go down rapidly and at the same time the right di-

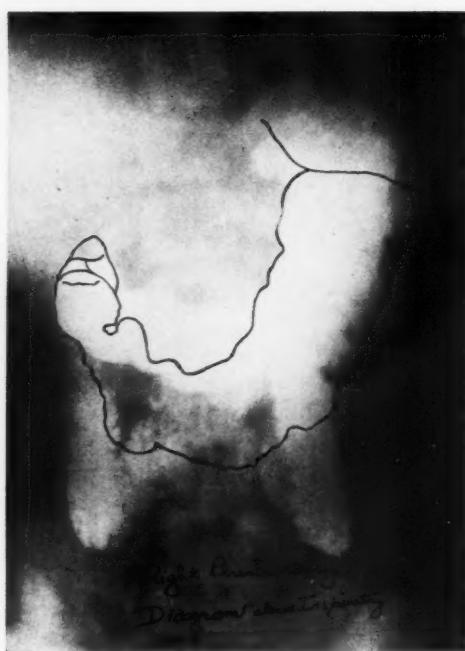


Fig. 5. Right phrenicotomy.

aphragm go up each time the left side goes down. This is the only instance in which we noticed an independent contraction and relaxation of each diaphragmatic leaf at any one moment. At all other times both sides contract and relax at the same moment. In belching, as the left leaf goes down and the right leaf goes up quickly and repeatedly the cardiac angle becomes less acute and soon the air is seen to find its way through the cardia into the esophagus.

#### DISCUSSION

Theoretically, one would assume that if the diaphragm plays an important rôle in gastric motility, we should expect gastro-intestinal disturbance after phrenicotomy. The absence of such symptoms would lead one to assume that either the diaphragm has no relationship with the gastro-intestinal tract or else that certain compensatory changes have taken place to modify conditions sufficiently to

establish normal function. The latter takes place in paralysis of the diaphragm. Under normal conditions the pillars open and close the cardia with each part of the respiratory phase in diaphragmatic mobility. The peripheral portion of the diaphragm not only pushes the fundus up and down but also aids in the lateral contraction of the fundus, thus reducing its diameter. Coincident with these changes the pars pylorica is modified in shape and diameter. When the diaphragm is paralyzed certain compensatory changes occur. These may be classified under three different groups.

1. The first group of patients is one in whom the diaphragm plays a secondary rôle in respiration, which is maintained mainly by the movements of the ribs. In this group of costal breathers paralysis of the diaphragm does not induce an improvement in the patient with tuberculosis and produces no change in the motility of the gastro-intestinal tract.

2. In the second group the right diaphragm has been paralyzed, the movements in the fundus are the same as normal, namely, a decensus, with a definite constriction. Coincident with these changes, there is a dilatation of the pars pylorica. There is a slight permanent deviation in the position of the pars pylorica towards the right side. The tendency to belching and vomiting is increased as a result of the relative rise of the right diaphragm and the change in the degree of the cardiac angle from the acute to the obtuse type.

3. In the third group in whom the left diaphragm was paralyzed, the imparted contractions were now transferred to the pars pylorica instead of the fundus and the latter remained more or less immobile. The pars pylorica swings back and forth much like a pendulum. At inspiration it moves laterally and slightly anteriorly. At expiration it moves medially and towards the spine.

Our present findings give us additional proof that the diaphragm plays an important rôle in influencing gastric peristalsis. The pillars control the opening and closure of the cardia. With each inspiratory contraction of the diaphragm, the pillars also contract and close the cardia sufficiently to block the fluid

barium meal from passing through. As soon as the diaphragm relaxes, the cardia opens and the barium runs into the stomach after it bends in an angle of about 90 degrees. The parietal portion of the left diaphragm presses down the fundus during each contraction and in so doing constricts the descended fundus and dilates the pars pylorica. As the diaphragm rises the fundus goes up with it and now the latter dilates while the pars pylorica contracts. In our previous papers (1, 2, 3) we have given evidence to justify our assumption that gastric motility may be definitely influenced by the contractions of the diaphragm. This paper furnishes a further proof of this relationship and incidentally explains altered physiology in gastric motility resulting from paralysis of one or the other leaf of the diaphragm.

#### BIBLIOGRAPHY

- (1) JOANNIDES, M.: Relation of Hiatus Esophagus of Diaphragm to Stomach; Important Function of Pillars of Diaphragm. *Arch. Int. Med.*, January, 1929, XLIII, 61-67.
- (2) Idem: Influence of Diaphragm on Esophagus and on Stomach. *Arch. Int. Med.*, December, 1929, XLIV, 856-861.
- (3) JOANNIDES, M., and LITSCHGI, JOSEPH J.: The Relation of the Diaphragm to Gastric Peristalsis. *RADIOLOGY*, October, 1931, XVII, 723.
- (4) ALVAREZ, W. C.: The Mechanics of the Digestive Tract. Second edition. P. B. Hoeber, New York, 1929, pp. 23, 97, 98.
- (5) McCREA, E. D., McSWINEY, B. A., MORRISON, J. W., and STOPFORD, J. B.: Normal movements of Stomach. *Quart. Jour. Exper. Physiol.*, 1924, XIV, 379-397.
- (6) TODD, T. W., and KUENZEL, W.: The Attainment of Reliability in Gastric Responses. *Jour. Lab. and Clin. Med.*, August, 1929, XIV, 1017.  
Idem: Gastric Responses to Milk and Butter-milk. *Jour. Lab. and Clin. Med.*, October, 1929, XV, 43.
- KUENZEL, W., and TODD, T. W.: The Reflex Effect of Heat and Cold upon Gastric Responses. *Jour. Lab. and Clin. Med.*, November, 1929, XV, 132.
- TODD, T. W., and KUENZEL, W.: Disturbances of Central Origin in Gastric Responses. *Jour. Lab. and Clin. Med.*, November, 1929, XV, 142.
- TODD, T. W., and ROWLANDS, M. E.: Emotional Interference in Gastric Behavior Patterns. *Jour. Comp. Psychol.*, April, 1930, X, 167.
- (7) HEDBLOM, C. A., and CANNON, W. B.: Some Conditions Affecting the Discharge of Food from the Stomach. *Am. Jour. Med. Sci.*, 1909, CVIII, 504-521.
- (8) COHEN, SEYMOUR J.: Personal Communication.
- (9) HRUBY, A. J., and DAVISON, R.: The Degree of Diaphragmatic Rise Resulting from Phrenic Nerve Paralysis. To be published.
- (10) CARMAN, R. D.: The Roentgen Diagnosis of Diseases of the Alimentary Tract. Second edition. W. B. Saunders Co., 1921, p. 44.
- (11) JOANNIDES, M.: Action of the Diaphragm during Belching: An Example of Independent Contraction in the Two Sides. *Jour. Thoracic Surg.*, April, 1933, II, 380.

#### THE SELECTION AND CARE OF THERAPY TUBES<sup>1</sup>

By DANIEL M. CLARK, M.D., SANTA BARBARA, CALIFORNIA

WITH two American and five foreign companies now engaged in the manufacture of therapy tubes, the selection of one which will operate most efficiently and economically under a given set of circumstances may be a confusing and difficult task. Too often the problem resolves into an argument on the relative merits of the various mechanical principles and construction details advocated by different

manufacturers. Unbiased opinions of experienced men are not easy to obtain, simply because their experience is usually confined to one make. The reliability of all the present manufacturers is rather well established; it is, therefore, safe to conclude that the product of any of them, given proper care and operated under the conditions and within the capacity for which it is designed, will give satisfactory service. There are more practical considerations.

Before attempting to select a tube, one

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should know definitely the factors of voltage and milliamperage under which it is to operate. This will be determined by personal preference as to the optimal voltage required and the volume of work to be undertaken. For various reasons, it is desirable to stay as far below the rated capacity as is consistent with the type and quantity of work to be undertaken. No tube will stand frequent or prolonged operation over its rated capacity. It must be remembered that factory tests are carried out under the most favorable conditions. Variations in output of from 10 to 15 per cent have often been demonstrated on two machines of similar type and manufacture under identical factors of voltage and milliamperage (1). It is, therefore, not unwise to select a tube the rated capacity of which is somewhat greater than that under which it is to operate.

The capacity of a tube may be materially reduced by improper cooling and ventilation. On the other hand, it may often be increased by the addition of some simple cooling device, such as an electric fan. Thus, while the factory rating of a certain tube may be 200 K.V.P., 8 ma., when it is operated in an ordinary lead glass bowl, if it is operated in a closed drum with blower cooling, the same tube may be run continuously at 200 K.V.P., 10 ma., an increase in output of 20 per cent. Similarly, a certain tube of foreign manufacture, designed to operate at 200 K.V.P., 4 ma., with a water cooling system of the reservoir type, may be safely run at 200 K.V.P., 8 ma., when a pressure water cooling system is used, an increase in output of 100 per cent (4).

When a tube is kept working in an ordinary lead glass bowl, the cooling conditions are never very good. This is particularly true if the distance between bowl and tube wall is not ample. When the distance is less than 3 cm., the capacity of the tube is materially less than its factory rating.

Most tubes are given a single factory rat-

ing, such as 150 K.V.P., 5 ma., but this does not mean, of course, that the tube cannot be operated under other factors. A tube may safely be run at somewhat higher milliamperage, if the potential is lowered to such an extent that the product of the kilovolt peak and the milliamperage remains constant. A tube with the above rating may, therefore, be operated at 130 K.V.P. 5.8 ma., or 100 K.V.P., 7.5 milliamperage. It is not safe, however, to operate at higher potential than factory rating, even though the milliamperage be correspondingly lowered.

As it is in the purchase of anything else mechanical, factory service is an important consideration. No matter how careful the workmanship and factory testing, it is inevitable that an occasional tube will be defective. Others are broken in transit. Serious difficulties have been encountered in the adjustment of such matters, particularly in the case of some of the foreign manufacturers. The remoteness of the factory, the language difficulty, the limited authority given to American representatives, and the difference between American and European business methods may be real obstacles in reaching an agreeable adjustment.

Next to efficiency, the most desirable quality in a tube is economy. This does not mean, of course, that the cheapest tube that will do the work is the most economical. However, in buying what may be termed an "extra-price" tube, one should make certain that the features which make it more expensive will be of value in the particular type of work it is to perform.

For convenience, a chart listing the various therapy tubes offered by one European and both American manufacturers is shown in Table I. The prices, which are quoted for delivery on the Pacific coast, will be slightly less in other parts of the country. It might also be explained that the American purchaser of a tube which sells for \$100.00,

TABLE I

Manufacturer	Deep therapy			Superficial therapy		
	Cooling	Capacity	Price	Cooling	Capacity	Price
General Electric X-ray Corp.	Water	30 ma. at 200 K.V.P.	450.00	Air	5 ma. at 140 K.V.P.	125.00
	Air	6 ma. at 200 K.V.P.	260.00			
Westinghouse X-ray Co., Inc.	Air	8 ma. at 200 K.V.P.	295.00	Air	5 ma. at 150 K.V.P.	125.00
C. H. F. Müller A.-G.	Water	180 K.V. at 4 ma.	480.00	Water	140 K.V. at 4 ma.	385.00
		200 K.V. at 4 ma.	590.00		160 K.V. at 4 ma.	460.00
	Air	180 K.V.P. at 4 ma.	215.00	Air	160 K.V. at 4 ma.	180.00
		180 K.V.P. at 8 ma.	265.00		160 K.V. at 8 ma.	215.00
		200 K.V.P. at 4 ma.	265.00			

F.O.B. European factory, pays \$40.00 United States import duty, \$4.00 United States customs entry charge, \$15.00 transportation and customs brokers' charge, \$1.45 insurance bonds and notary fees, and \$10.90 import brokers' commission, making a total of \$171.35.

Once a tube has been selected and installed for operation, the period of usefulness will be measured to a very great extent by the care it is given. Directions for its proper use and handling should be firmly impressed on all who have occasion to operate it.

External violence is the commonest cause of tube breakage, usually the result of careless handling, such as dropping a tube on the floor or swinging a side arm against the tube stand. The only correct way to carry a tube is with one hand firmly grasping each side arm. Few cases of "dropping" would be reported if strict adherence to this practice were rigidly enforced. The janitor's mopstick or broomhandle has put an end to the usefulness of many a tube. It is, therefore, worthwhile either to remove the tube to a place of security, or to run the tube holder to the top of the standard at the end

of the day. Water-cooled tubes are occasionally broken during installation by improper handling, in attaching the tubing for the water system (2). This should be done by a factory representative wherever feasible, or one thoroughly familiar with such work.

When a cold tube is put into operation, the impact of electrons brings about a sudden change of temperature, not only in the target, but, to some extent, throughout the entire tube. In high voltage therapy, therefore, it is essential to build up the voltage over a period of at least three minutes. This is done by starting around 100 K.V.P., and gradually increasing until the desired potential is reached. The procedure should always be carried out at the beginning of the day and repeated whenever the period between treatments has been of sufficient time to allow the tube to cool to room temperature (3). In cold weather, it is well to caution technicians and attendants against opening a window in the treatment room while the tube is hot. Uneven cooling, as a result of a sudden draft of cold air, may result in cracking.

Daily inspection of the cooling system of a tube is a sound practice and is most important when pressure water cooling is used. A temporary shutting-off of the water supply will often result in the destruction of the tube. In the reservoir type, small leaks are rather frequent, and, if any water falls on the tube during operation, the result is a punctured tube.

If a tube is operated when it is dirty, not only is the likelihood of puncture increased, but the life will be measurably shortened and the tube is more apt to become gassy. Daily clearing of a tube is, therefore, recommended. This can usually be accomplished with slightly dampened cheesecloth. If necessary, ether or carbon tetrachloride should be used to remove any remaining foreign material. It is hardly necessary to mention that the tube should not be operated until it is thoroughly dry.

Occasionally tube breakage may occur as the result of sparking across between rubber tube supports that have become carbonized (3). This danger may be obviated by periodically replacing rubber tube supports or substituting cork in their stead.

There is a good deal of confusion as to the signs of gas in a tube. Although many regard any flashing or color as due to gas, this is not true. In most instances, color is due simply to fluorescence. Every x-ray tube fluoresces, some considerably more than others, the amount and shade of color varying with the different types of glass used. It is very common to observe color in the anode arm; frequently, the entire bulb will show color. When a tube begins to show color in the cathode arm, however, it is nearing the end of its usefulness. There are two methods of testing a tube for gas. The first and most reliable is the test of operation. If a tube operates successfully up to full capacity, and the milliamperage does not show fluctuation, then it is not gassy, even though it may show color within its bulb.

A second method, the use of which is limited to the unenclosed types of tubes, is sometimes of value. This consists in looking into the bowl of the tube from an angle, that is, from the cathode or anode end. In the case of fluorescence, it will be observed that the color appears as a thin layer attached to the inner surface of the wall of the tube, whereas, if it is due to gas, the color will appear to be evenly distributed throughout the tube.

Sometimes, when a tube has become gassy, it is possible to operate it at lower voltage and milliamperage so that many useful hours are added to its life. In a case of this kind, the tube should be operated on such factors of voltage and milliamperage that no fluctuation or other disturbance occurs. In rare instances, after a period of operation in this manner, it is possible to return to the original voltage and milliamperage. It is probable that the old practice, not recommended by modern manufacturers, of seasoning a new tube by a period of operation at low voltage originated in this manner.

#### SUMMARY

1. The intelligent selection of a therapy tube is based on an understanding of the design and capacities of the products of various manufacturers, an evaluation of their qualities as applied to the particular type of work the tube is to perform, and the conditions under which it is to operate.

2. Economy of operation is possible only through an appreciation of a tube's fragility and through strict enforcement of rules governing its proper care and treatment.

#### BIBLIOGRAPHY

- (1) THORENS, ROBERT: On Running Conditions of Therapy Tubes. *Acta Radiol.*, 1927, VIII, 462-571.
- (2) GENERAL ELECTRIC X-RAY CORPORATION: Communication.
- (3) ERSKINE, A. W.: Personal communication.
- (4) WESTINGHOUSE X-RAY COMPANY, INC.: Rating chart.

## DISCUSSION

DR. R. R. NEWELL (San Francisco): Dr. Clark mentioned that fluorescence in the tube does not indicate gas. This is true; Dauvillier, in investigating certain vacuum tubes, especially valve tubes, noted that, the better the vacuum, the more fluorescence is apt to be manifested. Coolidge, at Pasadena last sum-

mer, said that fluorescence might be due to field currents, that is, cold cathode discharges hitting the glass. He projected a piece of the wall of a tube injured by these discharges, showing many fine channels in the glass. It is true that the fluorescence is not due to gas, but it may be important in regard to the life of the tube.

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## BRAIN ABSCESS RESULTING FROM AURAL AND SINUS INFECTIONS<sup>1</sup>

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**A**BSCESES of the brain, arising from infection of the paranasal sinuses or mastoid infection, are usually single, first passing through a stage of septic encephalitis, followed by encapsulation. If the infection of the brain is caused by highly virulent organisms, a rapid necrosis of the brain tissues may follow, and encapsulation does not take place. Treatment of an abscess of this type nearly always fails.

It is the purpose of this paper to discuss some of the important features of brain abscess and to describe a method of treatment which, in the author's hands, has given fairly satisfactory results. It is probable that the technic of operation for brain abscess will be further refined, and that reduction of the present mortality rate will be accomplished by applying different methods of operative treatment to different types of abscess. The size of the abscess, its subcortical depth, and the density of the capsule must all be taken into consideration in deciding whether or not drainage should be employed, and, if used, the selection of the point in the abscess wall into which the drainage material is to be placed. Multiple, metastatic abscesses are not considered, as they are rarely amenable to surgical treatment.

Brain abscesses arising from infection of the frontal sinuses usually develop in the adjacent frontal lobe. Those arising from aural infections are found either in the adjacent temporal lobe or the cerebellar hemisphere of the corresponding side. McEwen found cerebellar abscesses more frequently than those of the cerebral hemispheres. In a series of 31 cases of encapsulated brain abscess, we have recorded only three cases in which the abscess was located in the cerebellum.

While abscesses may result from penetrating wounds of the brain, or even from untreated scalp lacerations without fracture of the skull, it is rare for abscess of the brain to follow a primary acute infection either of the frontal sinuses or of the mastoid. It evidently requires a considerable period for infection to break down the barriers which exist between the inflammation of the bony cavities and the brain. It is generally believed that a transfer of infection from the sinuses, or mastoid, to the brain takes place through the blood vessels which enter the brain adjacent to the infected bone. Infected thrombi form in these vessels, and, by retrograde propagation, the infection enters the white substance, in which the blood supply is poor and the level of resistance to infection is low. In this stage, the inflammation of the brain in the region

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of the infected vein is diffuse, but tending to become encapsulated, provided the virulence of the organism is not overwhelming. It is thought that about three weeks are required for the abscess to become encapsulated. During the early stage of abscess formation, that is, during the stage of septic encephalitis, high temperature, chilly feeling, and evidence of systemic sepsis are present. These symptoms may erroneously be attributed to the antecedent infection of the sinuses. However, careful observation will show signs of intracranial involvement persisting, and even increasing, after operation on either the sinuses or mastoid. This is not consistent with uncomplicated infection of these cavities.

While brain abscess is a relatively infrequent result of infection of the paranasal sinuses or mastoid, the proximity of the infection to the brain and the possibility of transfer from the sinus to the brain are good reasons for a careful neurologic examination of every patient who is to be subjected to operation upon these bony cavities. Whether or not there has been an intracranial extension of the infection, should be determined, if possible, before operation.

Competent x-ray examination of the sinuses and skull is an indispensable part of the study of brain abscess. Frontal sinus infection may be accompanied by osteomyelitis of the skull involving the frontal bone. Subdural and encapsulated piaarachnoid abscesses are frequent consequences of the bone infection, and the bone involvement can be shown only by x-ray study. In one patient of our series, who presented air in the abscess cavity, the condition was diagnosed entirely so. This patient, who had a right temporal lobe abscess which was leaking through the mastoid wound, had no signs of intracranial involvement, except a homonymous upper quadrant defect in the left visual field.

After encapsulation of the abscess has

taken place, the patient's general condition usually appears to be greatly improved, although he frequently runs a slow pulse and is inclined to be less alert. As the pressure increases, stupor becomes more pronounced, and the patient's expression and conversation are more or less mechanical. If questioned, he complains of almost continuous headache; but, as a rule, he says little about headache unless he is reminded of it. The temperature, which is sometimes high before encapsulation takes place, may range from slightly above the normal to a degree below normal after the capsule has formed. The blood count is rarely elevated, unless a complication, such as extension of the abscess toward the surface of the brain, takes place. This so called "latent stage" may show certain focal signs, such as a slight weakness of the lower face on the opposite side. In large abscesses, there may be a definite weakness, or even hemiplegia, of the opposite side. In abscesses of the cerebellum, the progress of the case is usually very much more rapid, due to the association of an internal hydrocephalus, caused by blockage of the fluid in the posterior fossa. Choked disc was present in 50 per cent of the 31 cases of our series. Of the three cerebellar cases, two had only slight blurring of the discs before operation, whereas in one, the discs were normal.

The stage of abscess encapsulation may vary, sometimes lasting for many months. The condition, then, is one of intracranial pressure, plus certain focal phenomena, due to the location of the abscess. From time to time the patient may have attacks in which there is a sudden exacerbation of the symptoms, sometimes accompanied by a rise of temperature. A break in the abscess wall and the production of a pericapsular encephalitis or edema of the brain, produced by the abscess itself, may be responsible for these exacerbations. The favorable time for operation is during this latent, or sec-

ond, stage. There is no chance of benefiting the patient by operation in the first stage, when the brain infection is diffuse. In the terminal, or third, stage, the complication of meningitis, or respiratory failure due to medullary compression, has placed the patient beyond the help of surgery. The terminal stage is usually due to rupture of the abscess into the ventricle or subarachnoid spaces, with a fulminating meningitis as a result.

The main factor in the reduction of mortality in brain abscess has been the selection of the proper time for operation. It has been thought by some that the study of the discs might give information as to the best time to drain the abscess, and that progressive choking of the discs indicates the encephalitis has not been controlled. According to those who hold this view, operation at such a time gives a high mortality. But, when the swelling of the discs becomes stationary, one may believe that the abscess has become encapsulated, and it may be evacuated with less risk. If the history and symptoms indicate that encapsulation has taken place, one hesitates to assume the risk of delay in the presence of high intracranial pressure as shown by choked disc, inasmuch as the complication of rupture or medullary compression is always a real danger.

In certain cases with an indefinite history of antecedent infection, the diagnosis between abscess and tumor may be very difficult. In other cases (more or less rare) difficulty is found in making a localization of a suspected abscess. To decide between tumor and abscess, an exploratory puncture through a drill opening may be necessary. Ventriculography may, at times, be required. Careful neurologic examination with a searching inquiry into the sequence of events following the patient's primary sinus infection will furnish the main elements in the diagnosis of a large majority of cases of brain abscess.

#### TREATMENT

When there are reasonable grounds to suspect the existence of a brain abscess, associated with sinus or mastoid disease which has not been operated upon, the question often arises: Should the abscess of the brain or the sinus infection be operated upon first, or should both be dealt with at the same operation? In our own cases, if the intracranial involvement indicated brain abscess, and the mastoid or sinus disease was not threatening, we have first operated upon the brain abscess through a clean field, following this by treatment of the sinus or mastoid infection after complete recovery from the brain abscess. In abscesses of aural origin located in the temporal lobe, drainage may easily be made through the mastoid wound. However, should exploration fail to show an abscess, the patient would be subjected to the risk of meningitis.

The method of drainage which we have found satisfactory has been fully described in previous papers. Only a brief reference will be made here to the operative technic. We have routinely used the eye-end of a soft rubber catheter for drainage, whenever it could be inserted into the abscess cavity without great difficulty. In some cases in which the abscess is small and the capsule thick (particularly when the abscess is located at considerable depth), insertion of the catheter into the abscess cavity may be almost impossible without producing extensive trauma to the brain and widespread pericapsular encephalitis. To my mind, adequate drainage of the small, densely encapsulated, deeply seated abscess presents the greatest problem in the treatment of brain abscess. It may be that simple tapping, after Dandy's method, is to be preferred in some of these cases, or complete enucleation of the abscess might be attempted.

Drainage is facilitated by placing the tube in the lowest point of the abscess cavity. If the first puncture of the ventricular needle

enters the cavity at considerable depth, a second, or even third, puncture may be made in a different location, in order that the drainage tube may pass through the thinnest possible strip of normal cerebral tissue.

Death from unoperated brain abscess is generally caused by meningitis or medullary compression. Patients not surviving operation usually die of a septic encephalitis provoked by the surgeon's efforts at drainage, and not from meningitis, as is often stated. It is true that meningitis may be a terminal event in the septic encephalitis, but not the primary result of operation. In cases of virulent infection with rapid necrosis of brain tissue, particularly if the abscess is near the surface, it may be that King's method of "unroofing" would save an occasional patient. The results of operation are best in those cases in which there is a free flow of pus through the tube when it is first inserted. In some the pus is entirely evacuated at the time of operation, and there is little subsequent drainage, except that produced by the tissue reaction caused by pressure of the tube.

The post-operative recovery is not generally a smooth one. Much judgment is required to determine whether or not additional attempts should be made to drain the abscess. We have adopted a very conservative attitude in the treatment of these cases after the first operation. Frequently we have postponed, or even declined altogether, further operation, and we have had no occasion to regret a policy of delay or non-interference. One must remember that the fatal complication is generally septic enceph-

alitis, and that ill-advised surgery traumatizes the brain and spreads the infection, which might otherwise disappear, or become encapsulated.

In our experience, late residuals, such as convulsions, have been very infrequent. Naturally the type of residual would be determined by the location of the abscess. Abscesses of the motor area are likely to cause Jacksonian attacks or even hemiplegia.

The prognosis of brain abscess is good, if operation is performed at a favorable stage. It is possible for absorption of small abscesses to take place without operation, but removal of the abscess by absorption is too rare to be relied upon as a means of relief. The employment of simple methods of drainage has done much to lower the mortality, which was always high when trauma and a spreading encephalitis were added to the encapsulated infection. There is always a certain amount of encephalitis produced by any kind of operation for brain abscess. A fundamental requirement of the successful operation is the eradication of the abscess with minimum trauma and infection of the surrounding brain.

#### REFERENCES

1. DANDY, WALTER E.: Treatment of Chronic Abscess of the Brain by Tapping. *Jour. Am. Med. Assn.*, 1926, LXXXVII, 1477.
2. COLEMAN, C. C.: Some Observations on the Drainage of Subcortical Brain Abscess. *Arch. Surg.*, January, 1925, X, 212-216.
3. Idem: The Treatment of Abscess of the Brain. *Arch. Surg.*, January, 1929, XVIII, 100-116.
4. Idem: Reduction of Mortality of Brain Abscess by Simple Methods of Treatment. *South. Med. Jour.*, June, 1930, XXIII, 484-487.
5. Idem: Brain Abscess—A Review of 28 Cases, with Comment on the Ophthalmologic Observations. *Jour. Am. Med. Assn.*, Aug. 23, 1930, XCV, 568-571.

## THE CANCER PATIENT AND HIS DISEASE<sup>1</sup>

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EVERY cancer patient is a special law unto himself. In each case of cancer there are varying underlying causes which combine to effect the transformation of normal cells into a malignant newgrowth. The predominating causative factor in one person may be due to genetic errors of constitution and heredity. This is strikingly brought out in cases in which the same pathologic lesion attacks several members of the same family, and always the same organ. In another case it can be traced to constant traumatism, from within or without, as the exciting principle to start the disorderly growth. Curiously enough, in the majority of cases, cancer occurs in organs which were formerly quite undisturbed by illness; in individuals who have enjoyed good health until, suddenly, they present signs and symptoms of a malignant tumor.

The lack of fundamental knowledge of natural laws which govern normal growth, and want of information concerning constitutional errors responsible for tissue abnormality, put us at a loss to estimate the underlying cause of the malignant newgrowth. As a result of this, the influence of chief importance in the causation of the disease may vary as between individuals. This is one of the main reasons why malignant disease is essentially of differing biologic significance, and why the fundamental importance of malignant disease should be centered upon the patient himself.

In short, cancer in any two persons presents different entities. For example, the histopathology of two tumors may be alike, yet they may differ widely in their origin, exciting factors, and clinical course. So, too, the duration of the lesion is not a reliable index to foretell how long a patient

may live with his malignant disease. Tumors occurring in different parts of the same organ, particularly the uterus, also differ in their virulence. If the lesion involves the cervix, it is highly malignant; if it is situated in the fundus, its malignancy is less virulent and prognosis is much more favorable.

If from these preliminaries it is apparent how difficult it is to estimate the underlying biologic nature of the malignant disease, it becomes increasingly evident that the patient, with his tumor, is of paramount interest. This is best exemplified by two patients, each with a cancer of the breast, of the same size, in the same locality, of the same duration, one in a woman of 55, the other in a pregnant woman of 40. In the withered breast of the woman of 55, retrogressive changes have practically replaced the breast tissue, the organ is functionally passé, hence little lymph flows through it, and metastases to the axillæ will occur comparatively late. On the other hand, in cancer of the breast of the young, pregnant woman, we are dealing with an entirely different effect. Here the breast functions at its optimum, new acini are forming, and in such a breast the activity of the lymph flow is pronounced. Active lymph flow means that early dissemination has taken place, even before suspicion has been aroused that there is a primary lesion in the breast.

In other words, here we have a striking example of how differently malignancy in the breast behaves in two women, and how misleading it is to draw conclusions from statistics based upon dissimilar conditions. Having established the fact that the biologic behavior differs in the cancers of the breast of these two women, are we serving the best interest of the patients if we subject them

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both to the same routine method of treatment? In answer, let me emphasize the significance of my first sentence: Each patient with a cancer is a law unto himself.

The problem of malignancy is, and has been for centuries past, a perplexing and elusive one, notwithstanding the tremendous amount of research carried on by the best minds in the world. It is not my intention to sidetrack the importance of the disease itself, but generalization in cancer does not mean a thing, and the all-important question, which constantly confronts us, remains: What are we to do for the patient who is suffering with his cancer?

In the well conducted cancer clinics, in which each worker is trained in his particular specialty, it is the custom to confer about each cancer patient, and finally to decide upon the best method of procedure. In contrast to this, it is regrettable that the surgeon, who sees cancer with a surgical eye, or the radiologist, or the internist, should take it upon himself to assume the responsibility of pronouncing a judgment involving life or death. There should be no narrow individualism in the treatment of cancer. In every case, the evaluation of the disease and the constitutional study of the patient require the soundest judgment and experience; in addition, an intimate knowledge of the disease, its immediate outcome, and ultimate prognosis. In the vast majority of cases, this is not a one-man job.

Let us stop for a moment to consider: How have we approached the real problem? Most writers stress the pathology of the malignant tumor as it occurs in the various organs, basing their opinion and outlook upon one or the other method of treatment. While this sort of information may be interesting and significant, it is limited at best, as it leaves out of consideration the constitutional, physiologic, psychic, and other biologic features of the patient with his cancer.

If we now accept that the cancer process

is not one and the same thing in any two cases, and apply this in the accessible and easily recognizable tumors, note how the difficulty increases when we come in contact with the inaccessible and perplexing cancers of the stomach and intestine. These make up practically one-third of all malignant diseases, but, unfortunately, the patient in this group presents himself at the time when the tumor has grown to a size at which it produces symptoms of pressure, ulceration, or hemorrhage. Equally deplorable is the fact that early diagnosis of cancer of the stomach or colon is almost speculative, because rarely do clinical signs or symptoms assert themselves until quite late in the disease.

To digress for a moment, permit me to mention that the notion that cancer incidence is consistent with an age limit of 40 or over has blinded the profession to overlook cancer in persons younger than 40 years. Alvarez reported lately that, in his series of cancer of the gastro-intestinal tract, 10 per cent were in individuals under 40 years of age. In a recent publication by the writer, it was especially emphasized that cancer does not respect any age limit whatsoever; as a matter of fact, it occurs more frequently than is suspected in the young, and also in children. Consider that, in a series of nearly two thousand cases of brain tumor reported by Harvey Cushing, 20 per cent were found in the first two decades of life. In his series, brain tumors ran parallel in frequency with those of the breast and uterus, or at least very close to them. Moreover, of the renal tumors, 20 per cent are recorded in childhood, and every type of malignant disease is encountered in the young. To put this in another form: there is no age which is immune to cancer.

Continuing the subject of cancers affecting the gastro-intestinal tract, the symptoms of a malignant disease are so vague as to be entirely misleading. Not until the lesion has existed for many months, and pro-

duces definite symptoms, is it possible to recognize the presence of a tumor. As has already been indicated, in this group especially, I urge with great force that the patient is to be safeguarded. The surgeon, in his whole-hearted attempt to effect a cure, must keep ever before him "safety first" as his guiding principle. The radical surgical procedure must have in view, besides the removal of the tumor, *efficiency with safety*. Surgery of cancer of the colon is surgery of the lymphatic system of the colon, and it requires an intimate knowledge of the lymphatic anatomy and pathology. Nowhere is this better demonstrated than in cancer of the large intestine. Again, the magnitude of a radical surgical procedure is often beyond the power of the patient's endurance, and in most cases the best possible, or most radical, operation cannot be performed. Very frequently "safety first" demands that a less radical procedure be carried out. Therefore, it happens often enough that a surgeon is compelled to perform that which he knows to be an incomplete, and also imperfect, operation.

An appreciation of these principles represents the starting point of an adequate understanding of the patient and also of the beginning of the malignant process, and its ending.

If we now concede that this group of cancer tests the keenest judgment and experience of the surgeon and specialist, we can well appreciate how much greater are the difficulties in cancers which are inaccessible and inoperable from the start, as, for instance, the cancers of the pharynx, nasopharyngeal region, the esophagus, etc., or in post-operative recurrences and the cases in which surgery is impractical. Since only 20 per cent of the patients present themselves with an early diagnosis or at an operable stage, you will realize that the inoperable group constitutes the majority of patients with whom we come in contact, and yet

comparatively little has been said about them.

It is in this class that, as a last resort, the use of x-rays and radium has awakened the concern of the profession. Because of the hopeless outlook in these patients, the radiologist may well emphasize that 10 per cent have received much benefit from the radio-active substances, and that these agents have achieved here what no other methods of treatment had been able to accomplish. The limited time at my disposal does not permit me to dwell on the value of the x-ray and radium in these cases, but to stress the significance of the patient himself.

First, and foremost, every possible effort should be concentrated upon the patient himself, and what can be done to restore him to a state of health. Secondly, is the method of treatment directed to the tumor a safeguard against a recurrence of the same malignant disease?

If surgery is the method of choice, then a correct estimation is necessary of what the patient can stand at one time. Extensive and mutilating surgical procedures, often with no prospect of a cure, are a disappointing proof of the inadequacy of the method applied. This does not argue against incomplete operation, if its purpose is to relieve the patient of his discomfort or distress. The increase in cancer mortality raises the question of whether or not the present methods of treatment are qualified to cope with the malignant disease.

In accordance with this, there is, at the present time, a better understanding of the ineffectiveness of some of the former methods of treatment. For instance, the tongue is no longer excised when the regional glands are involved; cancer of the cervix is no longer synonymous with the Wertheim operation, and with the Coutard method of treatment of cancer of the larynx the patient is no longer subjected to the multilate-

ing operation of laryngectomy. After all, it is not merely the excision of the tumor, but the patient himself, who has to be reckoned with.

If, for instance, there is a disorder of metabolism or of the internal secretions, whatever therapy is indicated should be given conjointly with the treatment of the growth. This means more attention to stimulation and fortification of the natural defensive mechanism of the patient and less concentration on the direct attack upon the tumor itself. An individual with a badly depleted salt or water metabolism, and increased nitrogen retention, is no subject for surgical interference.

In this respect, it is reprehensible that methods other than surgery and irradiation are rarely mentioned, simply because the merits of any one method are measured by the yardstick of a permanent cure. For this

reason, the clinician has not been seriously concerned with the symptoms of anemias or toxemias, and the use of measures which may help to restore the patient's constitutional resistance, preferring to seek a therapy with vision of a cure.

Thorough clinical efficiency is necessary in the scientific management of the patient. In the face of grave prognosis and hopelessness of the disease, it would add immeasurably to the comfort and happiness of the patient if we instilled cheer and hope during our contacts with him. The physician who thinks only anatomically, chemically, or physiologically cannot understand the man before him, and fails to recognize the forces at work which tend to injure or benefit the patient. As a concluding sentence, permit me to quote Sir Frederick Treves: "In the face of misfortune, it is merciless to blot out hope."

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#### A CLINICAL AND ROENTGENOLOGIC STUDY OF FACTORS INFLUENCING THE PALPABILITY OF THE LIVER<sup>1</sup>

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##### LIVER SIZE

UNTIL recently, but few investigators have attempted to establish normal standards for liver size as determined by radiographic measurements. It has been customary to judge liver enlargement clinically by determining the level at which the liver can be palpated below the costal margin. The original purpose of our study was to test the validity of this practice, using X-ray mensuration as a criterion of size. The study was extended to include observations of factors, other than liver size, possibly influencing palpability. Pfahler (10), in 1926, made a series of 500 antero-posterior abdominal films, using a Bucky

technic and centering the rays over the ensiform cartilage. From a selected group of 324 of these, he determined the size of the liver, or, more correctly, the linear measurements of the right lobe of the liver. Two measurements were made; one, the length measurement of the distance from the tip of the right lobe to the farthest point on the dome of the diaphragm, and the other, the thickness measurement obtained by erecting a perpendicular to the inferior margin through the most distant point on the dome of the diaphragm. Moody and Van Nuys (8, 9) made routine postero-anterior and anteroposterior films in a similar study of 1,200 presumably normal young adults at the University of California. In their work, the rays were centered at the level of the

<sup>1</sup>Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

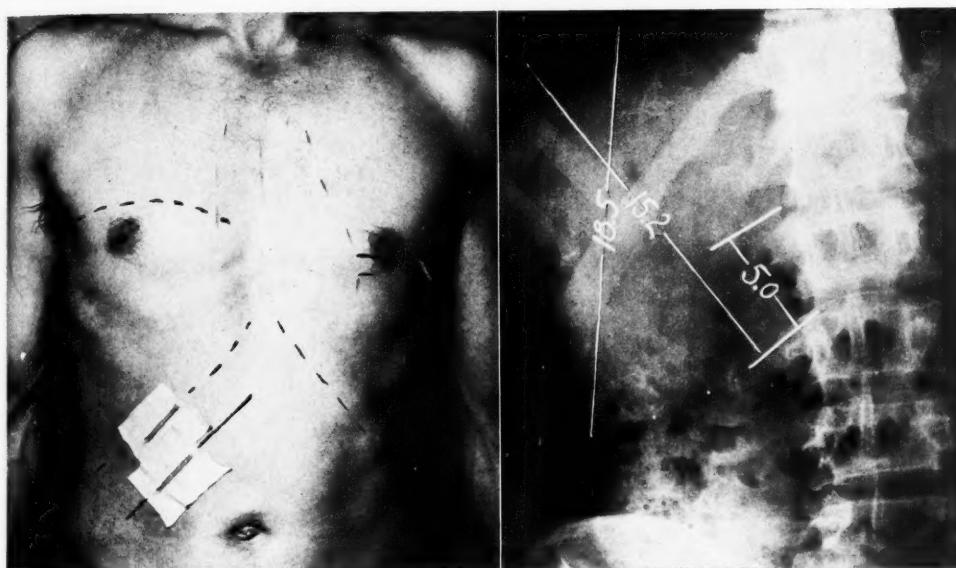


Fig. 1. (A) Showing method of placing wire markers on right costal margin in mid-clavicular line and at level below costal margin at which liver edge was palpated at deep inspiration. (B) A palpable liver with about average linear measurements, inferior margin lies approximately 5 cm. below costal margin at deep inspiration. Close clinical and roentgenological correlation in location of inferior margin (P.-A. inspiration).

interiliac line. Pfahler found the normal length of the right lobe to be from 18 to 22 cm. (average 21.3) and the thickness to be from 10 to 14 cm. (average 12.8), Moody and Van Nuys found 21.1 the average length. The variations found by the latter workers were somewhat greater and the upper limit of normal was placed at 25.5 centimeters. They made no measurements of the liver thickness.

We studied 53 individuals with palpable livers and a corresponding group of 53 with non-palpable livers. In general, all individuals with palpable livers examined during the period of this study were included. The subjects with non-palpable livers, forming the control group, were taken without selection from those undergoing examination. The palpable group was made up of 47 males and six females, the non-palpable, of 50 males and three females. The subjects of both groups were, in most instances,

without serious complaint. All were very thoroughly examined and in none was a definite clinical diagnosis of liver disease made. In all of the subjects, during quiet breathing, a copper wire marker was fixed by adhesive on the skin at the level of the right costal margin in the mid-clavicular line (Fig. 1). When the liver was palpable, a similar marker was placed parallel to the first at the lowest level in the mid-clavicular line at which the liver was felt during deep inspiration. Routinely, in the palpable group, four Bucky films were taken of the entire abdomen and upper pelvis, two with the patient in the postero-anterior and two with the patient in the anteroposterior position. In each of these two positions, one film was made at the end of inspiration and the other at the end of expiration. In each instance an effort was made to center the tube midway between the xiphoid and the umbilicus (or at about the level of the liver

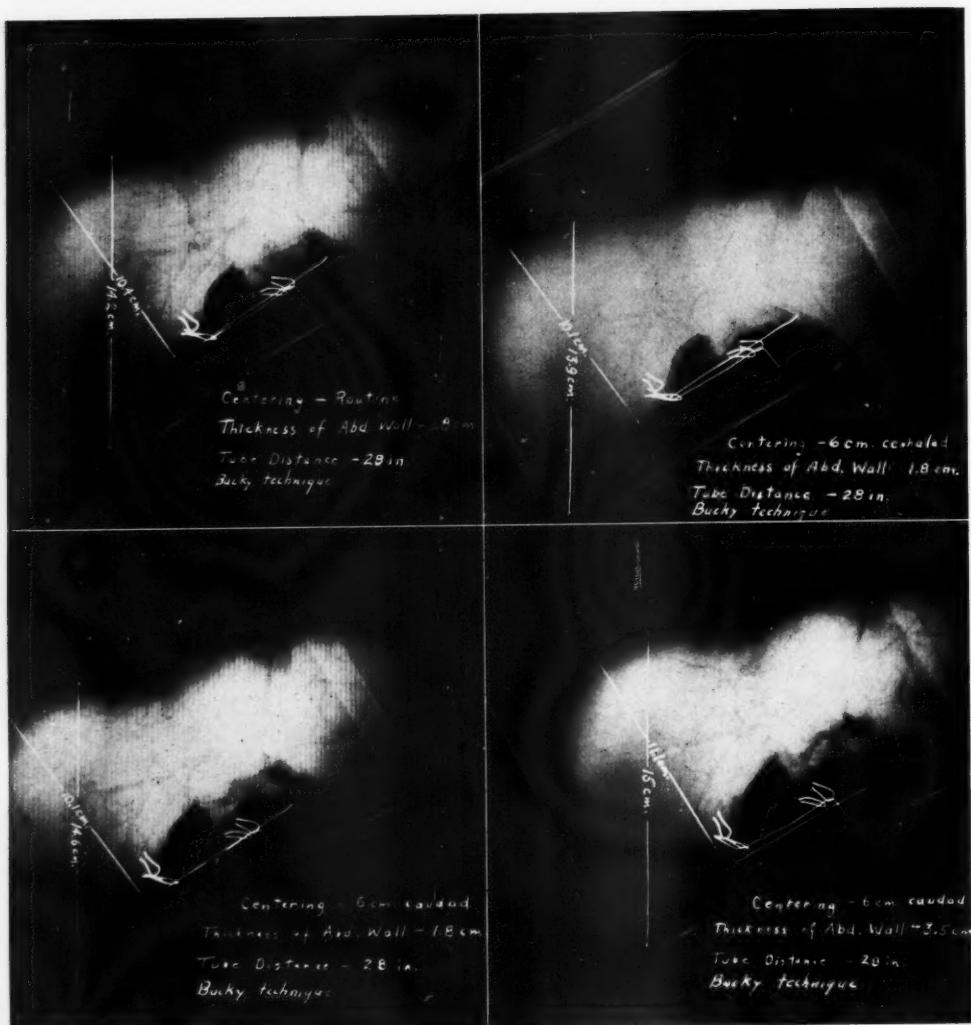


Fig. 2. Isolated liver studies to show small variation in measurements caused by improper centering of tube and by variable thickness of abdominal wall. (Liver in postero-anterior position.)

edge). The usual Bucky distance, 28 in., was a constant factor. (In the group of non-palpable livers only films at the end of inspiration were taken, since these two films gave the desired relationship of liver edge to costal margin and also afforded over-all measurements of the right lobe.) Measurements were made according to the method of Pfahler.

We have found that, with the usual Bucky technic, most individuals will show a fairly well defined inferior margin of the right lobe, although, occasionally, the margin cannot be located with sufficient accuracy to make the measurements reliable. Einhorn and Stewart (2) state that denser liver shadows are obtained after administration of dyes for gall-bladder function tests.

We did not find this so. Meyer-Betz (7) and Glenard and Aimard (4) suggest the injection of air into the stomach and colon or of oxygen into the peritoneal cavity as methods to bring the liver into relief on

and over the liver margin just as in the living subjects, and, in addition, a marker was placed directly on the inferior margin of the liver. The isolated liver was mounted in a cardboard box with the plane of its anterior

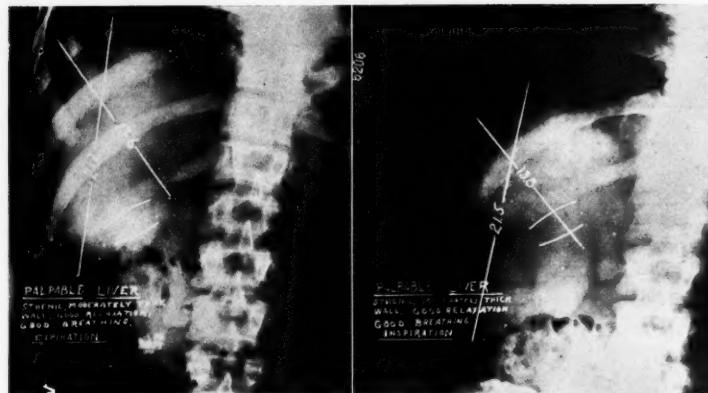


Fig. 3. Palpable liver (a) Expiration, (b) Inspiration. Average linear measurements. Inferior margin lies about 5 cm. below costal margin at inspiration and is several centimeters below liver margin marker.

roentgenograms. We have not felt it necessary to use either method routinely. The latter authors believe that the liver margin can be better determined by fluoroscopy than by radiography.

After radiographic study of this series had been largely completed, one of us, for a period of several months, investigated the visibility of the inferior margin of the liver routinely on all patients undergoing gastrointestinal examination during both vertical and horizontal fluoroscopy. It was found that the inferior margin often could be visualized rather well during deep breathing, especially with the patient in the horizontal position, and the excursion of the liver was thus noted.

To investigate errors in film measurements due to distortion and exaggeration, roentgenographic studies were made of a cadaver and of an isolated human liver. In the cadaver studies, wire markers were placed on the skin over the costal margin

surface parallel to the bottom of the box. The latter was built up to the thickness of an average abdominal wall. One wire marker was placed directly on the liver edge, and another directly anterior to it on the surface of the artificial abdominal wall. Carefully measured variables in the radiographic technic, such as improper centering of tube, improper position of patient, variable thickness of abdominal wall, and variable target film distance, were introduced (Fig. 2). These studies indicated that variations due to such factors as might be introduced during the routine radiographic technic were relatively insignificant for purposes of group comparison.

Table I gives the measurements obtained in our series of cases. Comparison of the average linear measurement on the films taken at inspiration with those taken at expiration shows no great difference, hence we might safely utilize either film as a part of a routine examination for consideration of

TABLE I.—LINEAR MEASUREMENTS

A.—*Palpable Group*

	Length of right lobe of liver				Thickness of right lobe of liver			
	A.-P. films		P.-A. films		A.-P. films		P.-A. films	
	Insp.	Exp.	Insp.	Exp.	Insp.	Exp.	Insp.	Exp.
Average	22.9	23.1	20.5	21.9	15.2	15.2	14.1	14.6
Highest figure	29.0	29.0	26.6	26.0	20.2	19.2	18.0	17.0
Lowest figure	17.0	17.5	14.5	17.5	11.3	11.4	10.5	12.3

B.—*Non-palpable Group*

	Length of right lobe of liver		Thickness of right lobe of liver	
	A.-P. films		P.-A. films	
	Insp.	Insp.	Insp.	Insp.
Average	22.3	21.6	14.5	13.9
Highest figure	30.2	28.0	18.3	17.5
Lowest figure	19.6	17.2	11.7	11.5
Standard deviation	2.286	2.19	1.45	1.37
Upper limit of normal	31.4	30.4	20.3	19.4
Lower limit of normal	13.2	12.8	8.7	8.4

TABLE II

Group	Liver Function				Gall-bladder Function			
	Total No. of Tests	Normal	Definitely Abnormal	Questionably Abnormal	Total No. of Tests	Normal	No. Filling	Poor Concentration or Sluggish Emptying
(A) Non-palpable	...	...	...	...	...	...	...	...
(B) Palpable	38	26	0	12	49	38	3	8
(1) Definite edge on re-examination	10	8	0	2	12	11	0	1

the relative size of the liver. In the non-palpable group, the average length measurement on anteroposterior films taken during deep inspiration (the "Pfahler film," except taken at inspiration instead of expiration) was 22.3 cm., which is 1 cm. greater than Pfahler's average, and 1.2 cm. greater than Moody and Van Nuys' average. The thickness measurement average of 14.5 cm. is 1.7 cm. greater than Pfahler's average. Surprisingly little difference was found in either the average, maximum, or minimum measurements of the right lobe on comparison of the 53 palpable livers with the same number of non-palpable ones.

In determining standards of normal size on the basis of the 53 non-palpable livers,

the statistical method was used. The standard deviation<sup>2</sup> was somewhat less in the postero-anterior view than in the antero-posterior. On the postero-anterior projection, it was 2.19 cm. for the length measurement and 1.37 cm. for the thickness. Considering nothing less than four times the standard deviation to be definitely abnormal, significant enlargement would necessitate a length measurement of 30.4 cm. and a thickness measurement of 19.4. On such a basis, none of the livers in this series, either palpable or non-palpable, was significantly enlarged (Table I).

<sup>2</sup>The standard deviation was arrived at by taking the individual differences from the average, and

$\sqrt{\frac{\text{sum of the squares of the differences}}{\text{number of cases}}}$

## LIVER AND GALL-BLADDER FUNCTION

A liver function test with iso-iodeikon was made on 38 patients of the series with palpable livers. In the others, the test was omitted, either because of some possible con-

one-half hour, and 5 per cent or less at one hour, is considered a normal finding. Of the 12 classified as questionably abnormal, 9 showed retention at one hour of from 6 to 10 per cent; of these, five showed reten-

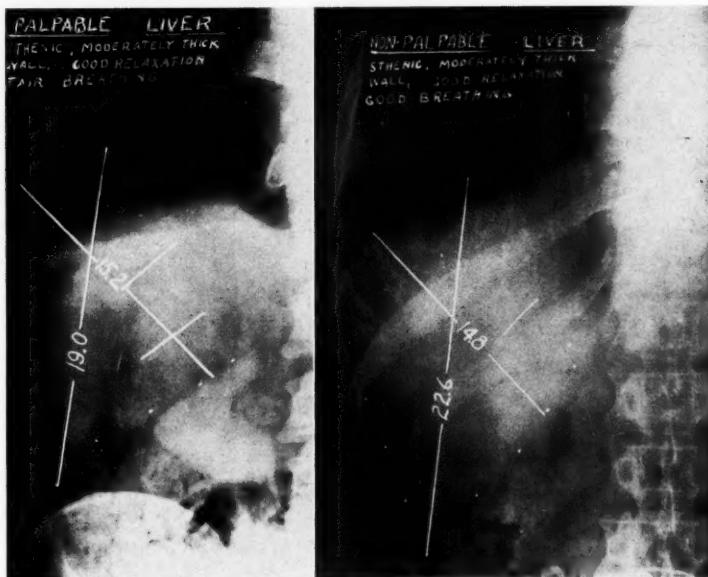


Fig. 4. (a) Palpable liver, inferior margin lies about 7 cm. below costal margin and about 3 cm. below liver margin marker (P.-A. inspiration). (b) Non-palpable liver, linear measurements slightly larger than in (a), inferior margin about 5 cm. below costal margin (P.-A. inspiration).

tra-indication to use of the dye, or poor co-operation on the part of the patient. The dye was prepared and the tests conducted in accordance with the accepted technic. There were no serious reactions. Graham gall-bladder function tests were made in all of our cases in which liver function tests were performed and, using the oral method, in 11 additional subjects in the group with palpable livers, making a total of 49 gall-bladder function studies in the group of 53 palpable livers.

Of the 38 liver function studies, 26 were normal and 12 were regarded as questionably abnormal. A retention in the bloodstream of about 12 per cent of the dye at

time of from 13 to 25 per cent at one-half hour. Three tests gave normal readings at one hour, but showed retention of from 20 to 40 per cent at a half-hour. None of the one-hour readings is more than 5 per cent increased. In view of the fact that we do not consider this colorimetric method reliable within 5 per cent, we do not consider definitely abnormal any of the 38 cases submitted to the liver function test. Of course, the iso-iodeikon liver function test is by no means an entirely satisfactory method for the positive determination of the presence or absence of liver pathology. The accuracy of this test and other dye tests has been discussed by Waters and King (11), Graham,

TABLE III.—FACTORS POSSIBLY INFLUENCING PALPABILITY

Group	No. of Cases				Build										
	Hypersthenic		Sthenic		Hyposthenic		Asthenic								
(A) Non-palpable	53	No. 3	% 6	No. 34	% 65	No. 3	% 6	No. 12	% 23						
(B) Palpable	53	No. 9	% 18	No. 29	% 56	No. 8	% 16	No. 5	% 10						
(1) Definite edge on re-examination	12	No. 1	% 8	No. 9	% 76	No. 0	% 0	No. 2	% 16						
Thickness Abdominal Wall															
Thick		Medium		Thin		Good		Relaxation Abdominal Wall							
No.	%	No.	%	No.	%	No.	%	No.	%	Poor					
7	22	13	42	11	36	10	50	7	35	3 15					
6	21	21	72	2	7	21	72	7	25	1 3					
1	8	10	84	1	8	12	100	0	0	0 0					
Breathing															
Good		Fair		Poor		Average discrepancy between liver margin marker and liver margin									
No.	%	No.	%	No.	%										
2	40	3	60	0	0										
13	48	12	44	2	8										
7	58	4	33	1	9										
2.2 cm.															
2.4 cm.															

TABLE IV

Group	No. of Cases	Average Length P.-A. Inspiration Film	Average Thickness Film	Average Distance Liver Margin below Costal Margin (cm.)	
				5.3	3.5
(A) Non-palpable	53	21.6	13.9		
(B) Palpable	53	20.5	14.1		
(1) Definite edge on re-examination	12	20.6	13.9		
				4.1	

Cole, Copher, and Moore (5), Barker (1), Greene, Snell, and Walters (6), and others. We may conclude that, insofar as the test with iso-iodine is an accurate index of liver function, the large majority of palpable livers in our group do not have abnormal function.

Of the 49 gall-bladder function tests (38 intravenous and 11 oral) only three showed complete non-filling; eight showed poor concentration or sluggish emptying; the remaining 38 (77 per cent) showed entirely normal Graham reactions. Of the 11 cases in which the Graham reaction was not entirely normal, the liver function was normal in four, questionably abnormal in four, and not tested in three. In view of the large percentage of strictly normal Graham function tests in our group of palpable livers,

we may conclude that there is no close correlation between palpability of the liver and gall-bladder function (Table II).

#### OTHER FACTORS POSSIBLY INFLUENCING PALPABILITY

Failure to find any significant difference in size between the palpable and non-palpable livers, and the absence of definite evidence of diminished liver or gall-bladder function in the great majority of the palpable livers, led to a consideration of other factors possibly influencing palpability. Body build, body weight, thickness and relaxation of the abdominal wall, depth of respiratory movements, and distance of the liver edge below the costal margin were given consideration (Table III).

FACTORS POSSIBLY INFLUENCING  
PALPABILITY

The judgment of the examiner in determining which livers were palpable was considered a possible source of error. At the

were compiled separately for the 12 cases in which a definite liver edge was felt (Table IV).

No certain correlation was found between body build and palpability of the liver;

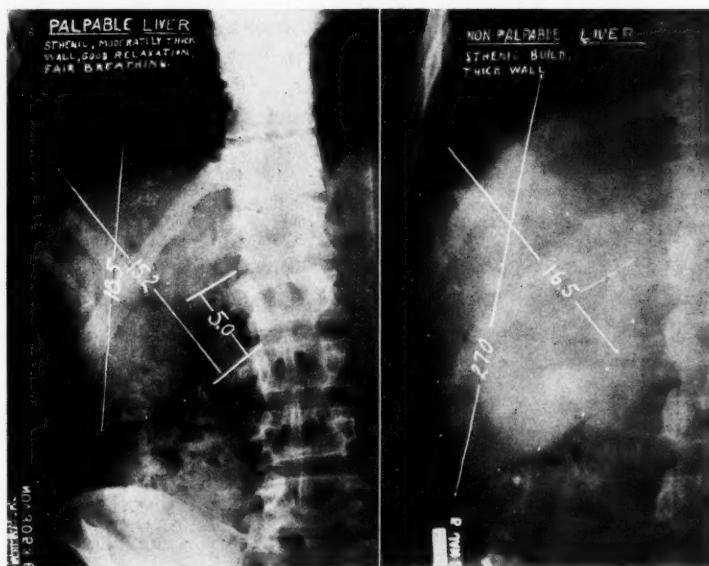


Fig. 5. (a) Palpable liver, inferior margin 5 cm. below costal margin: close agreement of clinical and roentgenologic localization of inferior margin (P.-A. inspiration). (b) Non-palpable liver, measurements well above average, but liver not significantly enlarged. Liver margin about 4 cm. below costal margin in mid-clavicular line (P.-A. inspiration).

time of the original studies, 19 of the 53 cases classed as having palpable livers were seen by at least two examiners. Twenty-seven of the original palpable group were recalled, and each was examined by three physicians. In nine cases there was unanimous agreement that a definite, sharply defined liver edge could be felt. In three cases, two of the examiners felt a definite edge, but a third did not feel it. In the remaining 15 cases, a definite edge could not be felt. In certain instances there was a sense of resistance, suggestive of liver; in others (even some in which the liver originally had been considered by two examiners to be palpable) nothing could be felt. Data

however, the original palpable group contained more hypersthenic and fewer asthenic individuals than the non-palpable group. We believe that a hypersthenic build may be more favorable to palpation, due to the fact that the inferior margin of the descending liver lies more transversely and, therefore, is more nearly perpendicular to the line of movement. In consequence, with respiration it meets the palpating hand squarely instead of obliquely.

No correlation was shown between body weight and palpability of the liver.

Thickness of the abdominal wall did not appear important in affecting palpability, there being about the same percentage of

thick-walled individuals in the palpable and non-palpable groups, with a larger percentage of thin-walled individuals in the non-palpable group.

A considerably higher percentage of in-

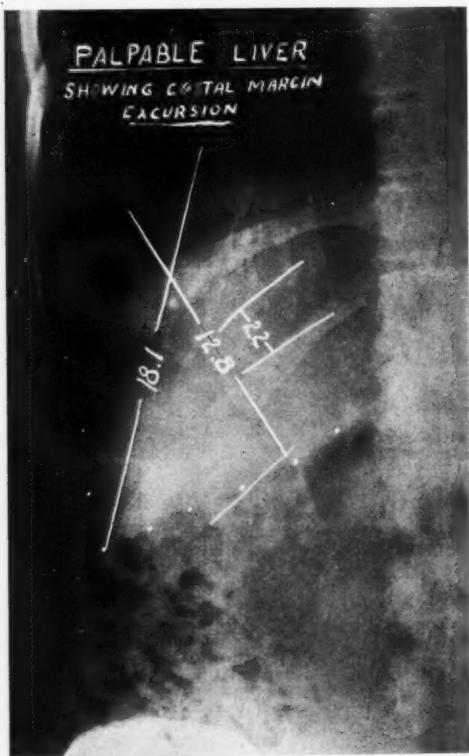


Fig. 6. Palpable liver with markers at liver margin. Costal margin quiet breathing, and (highest marker) costal margin, deep inspiration. Average discrepancy at deep inspiration between upward movement of costal margin and that of costal margin marker placed during quiet breathing, two centimeters.

dividuals in the palpable group was classed as having good relaxation of the wall. Since a liver cannot, of course, be felt through an absolutely rigid abdominal wall, relaxation must, at times, be a factor, although it has not seemed an important one in this series.

While, on most of our films taken at expiration, the inferior border of the liver was found to be near the costal margin, in nearly all instances, on satisfactory inspiration, the liver edge moved downward well below the

costal margin. The fluoroscopic observations, previously referred to, also showed in inspiration a descent of the liver border below the costal margin in almost every instance, usually for at least 3 cm. in the mid-clavicular line. Unsatisfactory breathing by the individual at the time of radiographic study undoubtedly was responsible for some of the greatest discrepancies between the radiographic and palpatory locations of the liver margin. Little correlation was found between palpability and the distance of the liver edge below the costal margin as determined by roentgenography. In the palpable group, the liver edge averaged only one centimeter lower than in the non-palpable group. In numerous cases in which the liver was not felt, the border lay quite definitely from 4 to 6 cm. below the costal margin, where it certainly should have been palpable, if location were the major factor. In a recent investigation of liver size in relation to gall-bladder disease, Feldman (3) reported 95 of 97 livers to lie above the costal margin, but he did not state clearly the position of the patient or the phase of respiration at which his observations were made. Toward the end of this study, it was realized that the wire marker placed over the costal margin during quiet respiration did not mark the position of the costal margin with the breath held at deep inspiration. The costal margin was found to move upward more than the marker, so that, at the end of inspiration, there was an average distance of two centimeters between them. This means that, in both the palpable and non-palpable groups, the liver margin during deep inspiration was actually about two centimeters farther below the costal margin in each case than our measurements indicate (Figs. 3, 4, 5, and 6).

#### COMMENT

That linear measurements of the right lobe of the liver give only a rough approxi-

mation of actual liver size seems obvious when one considers the well known variations in normal shape in different individuals. We do not feel that linear measurements are a very accurate index of size in

history and careful physical examination revealed clinical evidence suggestive of liver disease in but two of the subjects, and few of the subjects gave even slightly abnormal function tests.

COMPARISON OF LINEAR MEASUREMENTS AND RELATION OF INFERIOR  
MARGIN TO COSTAL MARGIN  
ON INSPIRATION

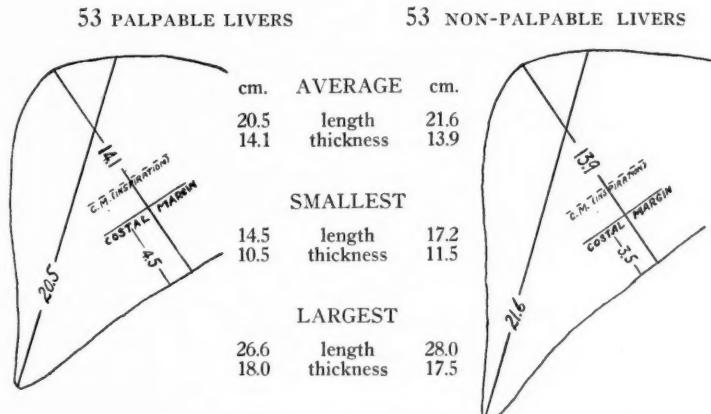


Fig. 7. Diagrammatic outlines of right lobe of liver in palpable and non-palpable groups. Over-all measurements of right lobe and relation inferior margin to costal margin not significantly different in the two groups.

any given case, but we do believe that there is something of value in the comparison of averages of large groups of cases. The absence of any appreciable difference between the palpable and non-palpable groups is rather striking (Fig. 7). After giving full consideration to all factors possibly influencing palpability, we have been forced to conclude that neither body build and weight, thickness and degree of relaxation of the abdominal wall, the depth of respiratory movements, the size of the liver, nor the distance that the liver projects below the costal margin have been found to be of great importance in determining palpability.

Firmness of the liver substance is a factor, probably of great importance, but which does not lend itself to direct observation, except at postmortem examination. Increased firmness might supposedly be due to fibrosis and to indicate disease. Detailed

The findings in the cases re-examined, which showed unquestionably palpable livers, corresponded to those in the entire group originally classed as palpable. Another series of subjects with palpable livers is being accumulated, and care is being taken to include no questionable cases, in an attempt to throw further light on the problem.<sup>3</sup>

#### CONCLUSIONS

Body build and weight, thickness and relaxation of the abdominal wall and depth of the respiratory movements were not demonstrated to be of major importance in explaining palpability of the liver, in our series.

As a rule, the inferior margin of the liver

<sup>3</sup>The authors wish to express their sincere appreciation to Dr. T. L. Squier for constructive criticism throughout the course of the study; Dr. Roy Benton for clinical assistance, Burr Anderson and Lyle Tyrrell for the illustrations, and Mrs. Evelyn Jensen for assistance in preparation of the manuscript.

lies at least several centimeters below the costal margin at deep inspiration, with the individual in the horizontal position.

Palpability of the liver rarely was associated with clinical evidence of disease or diminished dye excretion.

Palpable livers are not necessarily large livers. In our group their linear measurements were no greater than in an unselected control group of non-palpable livers.

#### BIBLIOGRAPHY

- (1) BARKER, L. F.: Three Cases of Portal Cirrhosis of the Liver with Comments on Etiology, on Some of the Newer Tests of Hepatic Function, and on Therapy. *Med. Clin. No. Am.*, July, 1930, XIV, 87-97.
- (2) EINHORN, MAX, and STEWART, W. H.: Hepatography. *Trans. Am. Gastro-enterol. Assn.* (1927), 1928, XXX, 200-202.
- (3) FELDMAN, M.: Liver Measurement; A Comparative Study on the Relation of Chronic Gall-bladder Disease to the Size of the Liver. *RADIOLOGY*, June, 1928, X, 496-499.
- (4) GLENARD and AIMARD: Palpation et Radiologie du Bord inférieur du Foie. *Bull. et mem. Soc. méd. d. hôp. d. Paris*, 1920, XLIV (3d ser.), 411-414.
- (5) GRAHAM, E. A., COLE, W. H., COPHER, G. H., and MOORE, SHERWOOD: Diseases of the Gall Bladder and Bile Ducts. Lea and Febiger, Philadelphia, 1928.
- (6) GREENE, CARL H., SNELL, ALBERT M., and WALTERS, WALTERMAN: Functional Tests in the Surgical Diagnosis and Treatment of Diseases of the Liver and Bile Ducts. *Jour. Lab. and Clin. Med.*, May, 1931, XVI, 765-774.
- (7) MEYER-BETZ, F.: Methode und klinische Bedeutung der Darstellung der Leber in Roentgenbild. *München. med. Wochenschr.*, 1924, LXI, 810-813.
- (8) MOODY, R. O., VAN NUYS, R. G., and CHAMBERLAIN, W. E.: Position of Stomach, Liver, and Colon: Results of Roentgenologic Study in 600 Adults. *Jour. Am. Med. Assn.*, Dec. 8, 1923, LXXXI, 1924-1931.
- (9) MOODY, R. O., and VAN NUYS, R. G.: Some Results of a Study of Roentgenograms of the Abdominal Viscera. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1928, XX, 348-358.
- (10) PFAHLER, G. E.: The Measurement of the Liver by Means of Roentgen Rays Based upon a Study of 502 Subjects. *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1926, XVI, 558-564.
- (11) WATERS, C. A., and KING, J. H.: The Intravenous Method of Cholecystography, and Liver Function Test as Employed in Office Practice. *Am. Jour. Roentgenol. and Rad. Ther.*, January, 1930, XXIII, 34-43.

#### OBSERVATION IN A PRELIMINARY STUDY OF TUMOR HISTOLOGY AND BONE METASTASES<sup>1</sup>

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**B**ONE metastases were recognized as early as 1834, by Sanson. In 1891, von Recklinghausen described two types: one, diffuse and destructive, which he termed osteomalacia carcinomatosis, and a second type, osteoplastic in character. Numerous cases have been reported, theories have been advanced as to the avenues of dissemination, and reasons have been suggested for the variations in these metastases.

Assmann believes that the presence of necrotic bone stimulates the production of new bone. Several observers have stated that hyperplastic lesions occur late and that they are secondary to an osteolytic process. Pfahler suggests that the sclerosis is prob-

ably an indication of Nature's attempt to isolate the disease, and that it is more frequently found in cases that develop slowly. Handley believes that the hyperplastic lesions are found in those cases in which there has been a non-infective inflammatory reaction in the bone, as a result of the tumor invasion. We will make no attempt at this time to discuss these and other theories, most of which we accept as logical deductions.

Leddy in his paper on bone metastases, including 40 cases, says: "There is, superficially, no relationship between the histologic character of the tumor and the incidence or type of metastasis."

Ewing has called our attention to the radioresistance of tumors which exhibit

<sup>1</sup>Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

TABLE I

Case Number	Age First Symptom	Age on Admission	Interval between Appearance and Death	Interval between Appearance and Bone Metastases*	Local Recurrence
555	37	40	4 years	2 years, 6 months	Yes
1324	56	56		1 month	No operation
104	43	44	1 year, 9 months	1 year	Yes
1182	62	69	7 years, 6 months	7 years	No operation
1002	68	69	2 years	1 year, 6 months	No operation
489	57	59	3 years	2 years, 6 months	No
1273	47	50	3 years, 9 months	3 years, 6 months	No
1022	43	44	8 months	2 months	No operation
732	66	68	3 years	2 years	
782	60	63	3 years, 10 months	3 years	Yes
586	42	44	2 years, 8 months	2 years, 7 months	No operation
1223	44	44		5 months	No
821	68	69	1 year, 3 months	1 year	No operation
450	81	81	1 year, 9 months	1 year, 3 months	No operation
1025	60	62	2 years, 6 months	2 years	Yes
1214	55	58	3 years (alive)	2 years, 6 months	Yes
435	60	61	1 year, 9 months (alive)	1 year, 6 months	No
540	32	38	7 years	6 years	Yes
1401	65	68	6 years (alive)	2 years, 8 months	No
175	79	80	9 years	9 months	No operation
Average	56.5	58.5	2 years, 6 months	2 years, 3 months	54 per cent of operable cases
Greatest Deviations $\pm$	81	81	7 years, 6 months	6 years	
from Average	$\pm$ 32	38	4 months	1 month	

\*This interval refers to the discovery of metastases, which, in some instances, were already present when the case was first seen.

TABLE II

Case Number	Tumor	Primary Location	Degree of Desmoplasia	Types of Metastases
104	Carcinoma simplex	Breast	DD	Sclerosing
175	Carcinoma simplex	Prostate	D	Destructive
435	Carcinoma simplex	Breast	D	Destructive and sclerosing
584	Squamous-cell carcinoma	Vagina	D	Destructive
450	Carcinoma	Prostate	DD	Sclerosing
540	Adenocarcinoma	Breast	O	Destructive
555	Carcinoma simplex	Breast	DD	Destructive and sclerosing
486	Epidermoid carcinoma	Cervix	O	Destructive
732	Hypernephroma	Adrenal	O	Destructive
782	Sarcoma (spindle)	Flank	D	Destructive
821	Fibrocarcinoma	Bladder	DDD	Sclerosing
1002	Carcinoma simplex	Breast	D	Destructive and sclerosing
1022	Adenocarcinoma	Kidney	DD	Destructive and slightly sclerosing
1025	Carcinoma simplex	Breast	DD	Destructive and slightly sclerosing
1182	Carcinoma simplex	Breast	D	Destructive
1214	Alveolar carcinoma	Breast	DDD	Sclerosing
1223	Medullary carcinoma	Breast	O	Destructive
1273	Carcinoma simplex	Breast	D	Destructive
1324	Carcinoma simplex	Breast	DD	Destructive and slightly sclerosing
1401	Scirrhous carcinoma	Breast	DDD	Destructive and slightly sclerosing

marked desmoplasia. In an effort, therefore, to estimate the radiosensitivity of our tumor cases, we have adopted the practice of carefully noting and reporting, in the histologic examination, the amount of desmoplasia.

There are at least two factors to be considered in the production of desmoplasia: one, which is a characteristic of the tumor cells of the individual case, and a second, which is a process of repair following necrosis. The former of these is the factor

which we feel is of more importance in this study.

The small group of cases, 20 in number, is not sufficient to establish any facts concerning bone metastases, but it does suggest to us another theory. If the primary tumor has the property of exciting a marked desmoplastic reaction in its growth, then this same property will manifest itself when bone metastases appear, and will stimulate a sclerosing type of lesion; also that the anaplastic, highly cellular tumors produce osteolytic changes in their bone metastases. There are, to be sure, various gradations of desmoplasia and anaplasia and the large percentage of primary neoplasms are both anaplastic and desmoplastic. Accordingly, in the majority of cases, both destructive and sclerosing lesions are prominent.

It would seem rational to believe that, if the primary tumor cells have the power to excite the growth of fibroblasts and young connective tissue, these identical cells, when lodged in the bones, would likewise stimulate the formation of osteoblasts, which are so closely akin to the fibroblasts. We do not believe with Kaufmann and others that epithelial cells can possibly become osteoblasts.

There are certainly numerous other factors concerned in the development of osteolytic and osteogenic metastatic lesions. The age of the patient, pre-existing constitutional diseases, and endocrine disturbances undoubtedly have their influences. Along

this line, we propose to make a study of the calcium metabolism in these cases, in an attempt to determine what rôle, if any, is played by the parathyroids.

#### CONCLUSIONS

The 20 unselected cases, all of which are included in our exhibit, suggest to us a theory of a relationship between the histology of the primary tumor and the character of its bone metastases. There are, undoubtedly, several other significant factors concerned in the genesis of bone metastases which help to explain the exceptions which we find to our theory.

#### DISCUSSION

DR. DOWNS (closing remarks): The one point I might add is that I hope other members, when they have the opportunity of seeing the histologic structures of the tumors, will attempt to correlate them with the roentgenograms.

There are numerous other factors, as we mentioned in our paper, which exert their influence on the type of metastases. We would not expect to find a sclerosed lesion in a person who already was old and had a generalized osteoporosis, nor would we expect it in a general carcinomatosis of the bone. Our bones, in themselves, are the storehouse of calcium, and, if all the available calcium has been used, the sclerosing lesion cannot be produced.

We have become very much interested in the work and I hope it will stimulate others to continue with the study.

## BRONCHOGRAPHY AN AID TO THE ROENTGENOLOGIST<sup>1</sup>

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**A**NY procedure which renders visible the invisible, is hailed with acclaim, as well as a vote of thanks from those whose work includes the attempt to evaluate the invisible. In the experience of all of us who study the intestinal tract by means of the roentgen ray, are instances in which the opaque medium has been observed to enter the tracheobronchial tract. In such cases we have been impressed with the absence of pulmonary reaction. The suggestion, then, of the intentional introduction of some contrast medium into the respiratory tract has been received with a genuine feeling of confidence by roentgenologists.

The method of introduction of iodized or bromized oil has been the subject of a rather voluminous literature. Each modification has its enthusiasts, depending first on the primary interest of the introducer, whether he be a bronchoscopist, pediatrician, internist, or other specialist, and secondarily the age of the patient for whom the procedure is contemplated. In general, the methods employed in the introduction of the oil into the bronchi fall under the following heads:

1. Through a bronchoscope, directly into the bronchus desired.
2. The intercricothyroid route, by which the oil is introduced into the trachea by an intercricothyroid puncture, through a trocar cannula resembling a tracheotomy tube, first used by Sicard and Forestier (1) and Armand-Delille (2).
3. Into the trachea through a tracheal or modified catheter under direct illumination with or without the employment of a laryngoscope.
4. Through an intubation tube, as suggested by Iglauer (3).

5. The "passive method" of Ochsner and Nesbit (23), by which, after anesthetizing the pharyngeal structures, the act of swallowing permits the oil to enter the trachea.
6. Instillation of the oil directly into the trachea with or without anesthesia of the pharynx, as suggested by Singer (4).

The last-named method is the least complicated; furthermore, it fills the requirements of the busy roentgenologist and is applicable in more than 80 per cent of cases. Preliminary anesthesia of the pharynx by spray of cocaine solution is required in only those cases possessing intolerant throats. A tracheal cannula cut to about two-thirds length, having a short bend at approximately  $105^{\circ}$  at the tip and fitted to a 20 c.c. syringe, is all the apparatus required (Fig. 2).

The patient is seated, inclining to the side to which the physician desires the oil to gravitate; the tongue is grasped with the aid of a gauze sponge, pulled forward to the limit of comfort, and the oil dropped into the trachea during inspiration. The exact position the cannula tip should occupy is that in which single drops of the oil seem to be deflected exactly upward by the current of air of expiration coming from the trachea. A beam of reflected or direct light will assist in locating this exact point. The entire procedure consumes only slightly more time than the average fluoroscopic examination, and, if desired, the degree of filling can be observed fluoroscopically.

The field of application of bronchography is potentially narrow, being limited to those lesions not otherwise radiographically apparent and specifically that group in which the visualization of the bronchi may add amplification. These lesions obviously comprise those which affect the lumen of the

<sup>1</sup>Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

bronchus by obstruction, stenosis, dilatation, position, course, and relationship.

The chief indications for bronchography may be classified as follows:

1. Bronchiectasis, and the study of the post-cardiac space.

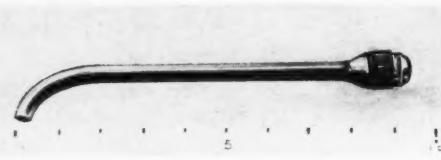


Fig. 1. An ordinary silver intratracheal cannula cut to about 9 cm. length, including a short bend at the tip of approximately 115 degrees, fitted to a 20 c.c. Luer type syringe, has proven most satisfactory for an intratracheal instillation of the oil.

2. The differentiation of lesions of the pleural cavity from those of the lung parenchyma.
3. The effect of therapeutic efforts, particularly multiple stage operations, and the evaluation of residual pathology.
4. The localization of the trachea and bronchi as an aid in differentiation of lesions of the mediastinum and pericardium.

It is well to recall that the bronchial tree, in addition to its classical function, acts as a support to the parenchymal structures. The terminal bronchi, in contrast to the primary branches, contain no cartilaginous rings, and, therefore, receive rather than transmit support. Ballon and Ballon (5) have shown that the position of the larger bronchi are fairly constant in man and quote Ewart as having proved by calculation that the lungs of infants contain the same elements as those of the adult, their size only being different; consequently, the normal bronchial tree as visualized by the bronchograph at various age periods is constant. "The size of the products of a bifurcation of a bronchus is equal to that of the parent," quoting the same author, and, of two diverging bronchi, the smaller diverges most from the position of the parent tube. The bifurcation

of the trachea shows a variation as to the exact site in the normal subject; the left bronchus is more oblique and is smaller than the right, which is shorter and wider, passing down as a direct continuation of the trachea.



Fig. 2. The patient is seated in an upright position, inclined to the right or left as desired. The tip of the tongue is grasped with a gauze sponge and pulled forward to the limit of comfort. The lower position of the tongue permits the saliva to flow out of the mouth. The position of the tip of the cannula is determined by the character of the deflection of a drop at the cannula tip and injection is made directly into the trachea during inspiration.

Bronchiectasis, the most frequent indication for bronchography, is defined as a dilatation and an inflammatory process in the wall of a bronchus or the entire bronchial tree. It has been the subject of intensive study by many workers since the advent of the application of bronchography. Hartung (6) showed in an analysis of 92 cases that the diagnosis of bronchiectasis could be made in only 60 per cent from the plain films, and it has been proven repeatedly that the signs of bronchiectasis upon which we have previously depended, are present in only late stages of the affection. Much has been written regarding the etiology of both

the congenital and acquired types. A review of the literature and our own experience has led to the following classifications as to etiology:

1. CONGENITAL

- (a) Arrest in development
- (b) Accumulation of fluid
- (c) Adenoma
- (d) Pressure
- (e) Congenital syphilis
- (f) Valvular bronchial stenosis

2. ACQUIRED

(a) *Non-infectious*:

- 1. Foreign body
- 2. Tumor (aneurysm)
- 3. Cicatricial stenosis (scar tissue)
- 4. Plugging of bronchus from rare causes.

(b) *Infectious*:

- 1. Co-existent with paranasal sinusitis
- 2. General bronchiectasis in young children following acute bronchitis
- 3. Bronchial dilatation co-existent with atelectasis
- 4. Following fibroid pulmonary tuberculosis
- 5. Following pneumonia and lung abscess
- 6. Following empyema
- 7. Following acute or chronic bronchitis
- 8. Following measles, influenza, or pertussis.

Regarding the bacteriology of bronchiectasis, L. H. Ermatinger (7) reports, from a series of 33 cases of bronchiectasis at Barnes Hospital, the following organisms, and percentage of incidence:

1. *Micrococcus catarrhalis* (90 per cent)
2. *Staphylococcus aureus* (60 per cent)
3. *Hemolytic streptococcus* (40 per cent)
4. *B. Mucosus-capsulatus* (40 per cent)
5. *Pneumococcus* (40 per cent)
6. *Bacillus xerosis* (30 per cent)
7. *Fusiform bacillus* (10 per cent)

He considered the predisposing factors to be: foreign body (broncholithiasis) influ-

enza, pneumonia, measles, bronchitis, pertussis, and tonsillectomy.

One regards the congenital type of bronchiectasis as the only dilatation that is congenital. The nature and course of the process of dilatation is rather indefinite, though several suggestions in explanation have been offered, for instance, the theory of arrest in development as advanced by Kaufmann (8) and supported by Pepere and Dionisi, and the suggestion of Grawitz (9) that an accumulation of fluid in the fetal bronchioles is the cause of dilatation in many cases. Congenital fetal adenoma was considered the etiological factor in many cases reported by Stoerk (10). Sauerbruch (11, 20) suggests that the crowding of the left main bronchus during early development by Cuvier's duct should not be overlooked, and Blazer and Grandhomme (12), with others, claim that congenital syphilis plays an important rôle.

Bronchiectasis when acquired and of a non-infectious origin may be due to a partial or complete blocking of the bronchus from such agents as a foreign body, a tumor, *et cetera*. One of the earliest workers on this subject, Reynaud (13), observed that the dilatation usually occurred both distal and proximal to the point of obstruction as well as in the nearby unobstructed branches. All seem to agree that although non-infectious in origin, infection soon becomes a complicating factor.

Corrigan (14) observed the relationship between fibrosis of the lung and bronchiectasis in that the scar tissue retraction in the lung was the source of extra-bronchial traction resulting in dilatation. In cases of bronchiectasis associated with chronic fibroid phthisis, the dilatation can be accounted for by the scar tissue retraction of the bronchial walls. The same may be applied to chronic empyema. In any condition in which an inflammatory process has weakened the bronchial wall it must be considered as most

important as an exciting cause. The same is particularly logical in cases in which the dilatation is localized.

Rist (15), a French surgeon, was the first to observe and call attention to the association of bronchiectasis and upper respiratory

Bronchitis, 16 per cent  
Pneumonia, 16 per cent  
Infectious disease of children, 13.6 per cent  
Foreign bodies in the bronchus, 5.2 per cent  
Post-operative pulmonary infection, 4.7 per cent.

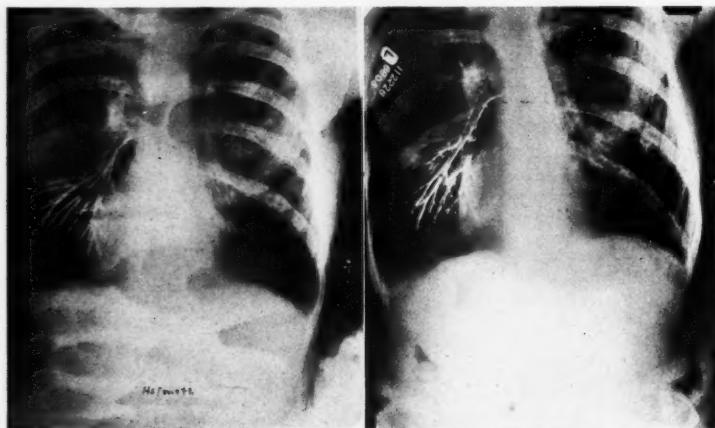


Fig. 3. Bronchographs of right lower lobe, same patient, at a thirty-day interval, demonstrating consistency of a bronchograph obtained after the instillation of iodized oil by the method of Singer.

infections, and Webb and Gilbert (16), in 1921, were the first in this country to advocate roentgen examination of the sinuses in such cases. From a series of their cases they found the pus from washing contained the same organisms as the sputum, usually *Pneumococci*.

The experimental work of Mullin (17) has shown the two routes which connect the accessory sinuses to the lungs and bronchi to be, first, the lymphatic circulatory route and, second, the inhalation or bronchial route. The former can function even in the case of an antrum which does not discharge at all into the nose, and the latter is open to any substance reaching the nasal fossæ, provided it be converted into droplets or aspirated by inspiration.

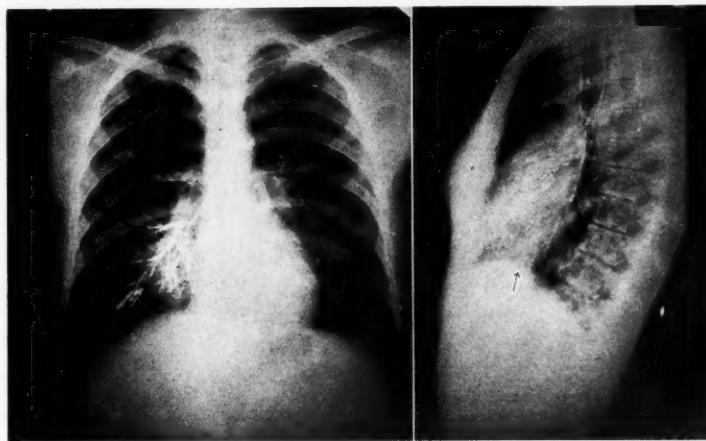
In a series of 552 cases of bronchiectasis, reported by Hedblom (18), the causes given are as follows:

The greater percentage, therefore, must come from some remote cause. Quinn and Myer (19) report a series of 38 cases of bronchiectasis in which 20 (or 57.9 per cent) had a co-existent sinusitis. Dennis reported that in 52 patients with bronchiectasis, 47 had involvement of the maxillary sinus. Lockwood's analysis of the incidence of pulmonary fibrosis, with nasal sinus disease, points to a rational mechanism. The types of sinusitis regarded as of etiologic significance are, in the order of their frequency, pan-sinusitis, bilateral maxillary sinusitis, and ethmoiditis. As though to prove the rule, a series reported by Quinn and Myer, the majority did not have—or give—a history of sinusitis.

Regarding detail pathology, the congenital types of bronchiectasis are of two main varieties. In one form there is usually failure of development of the alveolar sacs

associated with enlargement of the members of the bronchial tree. There is a cylindrical enlargement, with little or no inflammation of the bronchi. It is ordinarily discovered accidentally, rather than because of symptoms, and as a rule is limited to one lobe,

cur in combination. The alveoli between are crushed and collapsed and undergo permanent cicatricial atrophy. From mutual pressure, the walls of touching ectatic secondary bronchi may disappear, and several form a communal sac analogous to anasto-



Figs. 4-A and 4-B. Localized bronchiectasis secondary to bronchial stenosis. Note the fine adhesion of the diaphragm in the lateral projection, indicated by arrow, and the failure of visualization by the oil at this segment of the lower lobe. Confirmed by bronchoscopic examination.

although it may be more widespread. In the second form, such as that described by Koeckert, the alveoli show complete failure of development and the bronchus grows out from the primary tube as an extremely thin-walled, cyst-like mass replacing an entire lobe or an entire lung. It is, therefore, a balloon-like distention of an improperly developed large bronchus. It is lined by cylindrical epithelium, and in its wall shows isolated areas of cartilage and of muscle. If extensive, the condition is not consistent with life.

According to the form, pathologists speak of cylindrical or diffuse, and sacculated or circumscribed bronchiectasis, with the spindle-shaped form between. When several saccular dilatations follow one other, the condition is referred to as "varicose bronchiectasis," and several forms may occur in combination.

In rare cases an extensive cavity takes the place of a large area of the lung.

Diffuse bronchiectasis often presents uniform dilatation extending to the pleura, while frequently the extreme distal ramifications are most markedly dilated. The diffuse type of lesions are found most frequently in the lower lobes. When the lesion is of the saccular or spindle-shaped type, efferent small branches, as well as the central area, are frequently seen, and may also reach the periphery. Purely saccular dilatations are found most frequently in the upper lobes. The walls of the bronchiectatic bronchus may be either atrophic (if the wall is thinned to a transparent serosa-like membrane) or hypertrophic, in which case the wall is changed as in chronic catarrh, often polypoid, moist, and vascular, the latter

condition offering an explanation of bronchial hemorrhage in bronchiectasis. The wall is surrounded by abundant fibrous tissue and trabecular hypertrophy, which accounts for the honeycomb appearance seen in advanced cases. The contents varies

The abnormal position and the relationship of the bronchi offer the differential criteria.

The bronchograph is the means of accurate evaluation of therapeutic results, by both operative and non-operative measures, including the multiple stage operation, par-

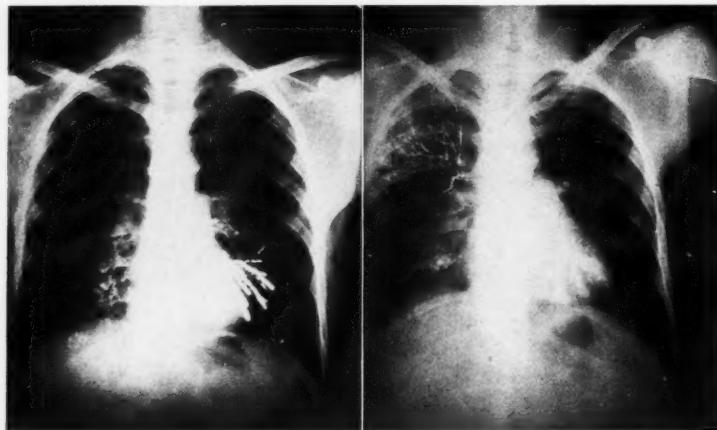


Fig. 5 (left). Bronchograph of the left lower lobe showing cylindrical bronchiectasis. The oil in the right lower lobe remains from a previous instillation. Cf. Fig. 6.

Fig. 6 (right). The oil is shifted to the right upper lobe by turning the patient on the right side in a semi-inverted position. Cf. Fig. 5.

from air to thick, slimy secretion or grumous, cheesy material, the latter occasionally calcified.

The Ballons' (5) classification of bronchiectasis, based on the injection of iodized oil, includes five types, *viz.*, cylindrical, grape, bead, clubbed, and saccular. They consider these types as denoting the age of the disease as well as describing the condition of the bronchus and distal lung parenchyma. Any classification is destined to prove inadequate, due to overlapping of types.

The value of bronchography in the differentiation of lesions of the pleural cavity from those of the lung parenchyma include infiltrations at either site, particularly pneumonitis, massive pleural thickening, infiltrative tumors, encysted hydrothoraces, etc.

tial or complete thoracoplasty, pneumothorax, postural or localized drainage, as well as other measures. Radiologists depend on the importance of the position of the trachea as a differential guide in cases of extensive pulmonary pathology. When such is invisible as a result of extensive mediastinal infiltration or neoplasm, cardio-aortic or pericardial pathology, the handicap may be overcome by bronchography.

The contra-indications for the employment of the method are, grossly, those which alone deny the mechanical manipulation of the procedure, such as advanced cardiac disease with respiratory embarrassment and the presence of acute or recent upper respiratory infections. Advanced pulmonary tuberculosis—certainly in those cases accompanied by marked elevation of

temperature or recent hemoptysis—constitutes a contra-indication, recalling, however, that hemoptysis frequently accompanies bronchiectasis.

Pritchard, Whyte, and Gordon (22) report six cases of mild iodism in the form of

ties should not be employed for this reason if for no other. Archibald and Brown (24) point out the danger of the plugging action of the oil as it floats above the purulent secretion and theoretically causes the longer retention of infected material, and that the

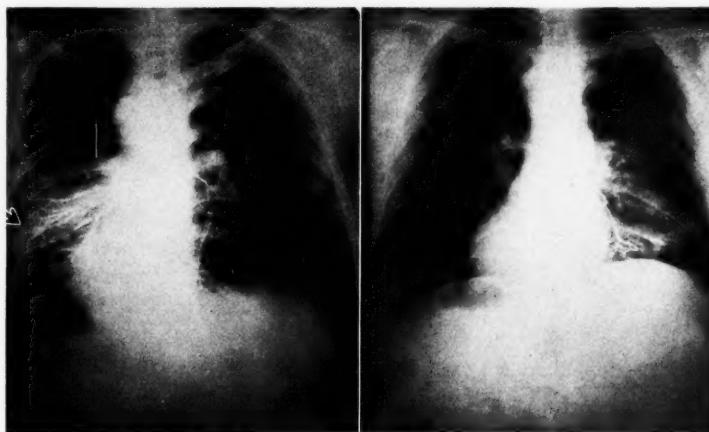


Fig. 7 (left). Localized bronchiectasis (indicated by arrow) following a lung abscess which was treated by pneumothorax.

Fig. 8 (right). Pulmonary fibrosis secondary to resolving lobar pneumonia, illustrating altered bronchial radiation.

an irritable rash in a series of 1,000 cases. Archibald (21) cites Forestier as having shown the elimination of 0.02 grm. iodide in the first 24 hours following the administration of 20 c.c. of lipiodol. Brauer adds three cases of iodism after lipiodol. Therefore, cases of hyperthyroidism, and particularly those taking iodine, should not receive iodized oil.

Particular attention should be given to the danger of the split of the chemical compound in the presence of the alkaline intestinal secretions. If a considerable quantity of the oil is swallowed, a cathartic should be administered to hurry the passage of the oil.

The potential reduction in vital capacity, as a result of the introduction of the oil, should be kept in mind in choosing patients to receive the oil, and useless large quanti-

oil may operate as an obstruction to alveolar respiration. While such a theory appears to be sound and should be considered in the evaluation of the bronchographic risk, neither of the above objections has proven practically to be serious, in our experience. The reaction within the bronchus or alveolus does not seem to parallel that which occurs in the pericardium or spinal canal as reported in recent literature.

The location to which the oil will gravitate is determined by the position of the patient during, as well as immediately after, the injection. We have frequently been successful in visualizing the larger bronchi of all the lobes at a single effort. To be sure, the oil must be shifted from the lower to the upper lobes for the visualization of the latter, whatever method of introduction is employed, except the bronchoscopic

method and possibly the tracheal catheter method.

After visualization of the left lower bronchi the patient is placed on his left side and the head lowered to about 45 degrees, whereupon the oil will be seen to flow into

Over-filling of the bronchi should be avoided because of the resulting confusion of superimposed shadows. Technically good stereoscopic films in the postero-anterior projection, as well as a lateral projection, should be routine in order to evaluate par-

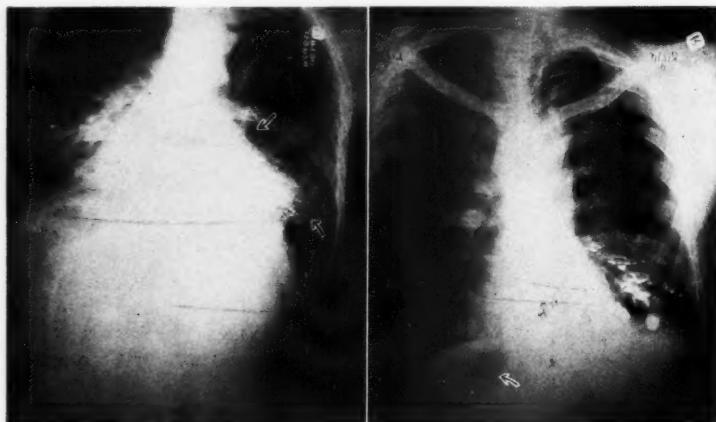


Fig. 9 (left). Adhesive pericarditis and extensive cardiopulmonary fibrosis, illustrating the reduction of bronchial radiation, confirmed by autopsy.

Fig. 10 (right). Saccular bronchiectasis, congenital, in the right lower lobe. This patient also presented a first degree cylindric bronchiectasis of the left lower lobe, acquired. Note transposition of the viscera. (Film reversed.) This is particularly interesting in support of the theory advanced by Sauerbruch.

the bronchi of the left upper lobe. Radiographs can be made while the patient's head is kept low. If he is turned on his right side and returned to the upright or semi-upright position, the oil will flow into the right lower lobe; finally, on returning him to a 45-degree inverted position, the oil will flow into the right middle and upper lobes.

The successful shift of the oil from one lobe to another requires complete co-operation on the part of the patient. A lessening of the tendency to cough will be effected by a gradual change in posture, for which manipulation the modern tilt-top table is ideal. When extensive shifting of the oil is contemplated a preliminary spray of from 2 to 4 c.c. of 1 per cent cocaine solution during deep inspiration will assist in preventing the cough reflex.

tial fillings. A slightly greater exposure of intensity should be used to assure registration through the heart shadow as well as the domes of the diaphragm. The bronchograph stands as an excellent example of the necessity for rapid exposure time in chest radiography in order that involuntary movements may be avoided.

Since a large amount of the oil is expelled by coughing, exposures should be made promptly after the injection. The normal lung retains a considerable quantity for days or even weeks and, in the event of re-examination, that fact must be borne in mind.

#### SUMMARY

1. The methods of introduction of iodized oil into the tracheo-bronchial tree are mentioned in outline and Singer's method described.

2. A classification of the indications for bronchography is given.
3. A classification of the etiology of bronchiectasis is given.
4. The etiology and pathology of bronchiectasis are discussed.
5. The value of the bronchograph in pathologies other than bronchiectasis is pointed out.
6. Contra-indications are mentioned.

#### CONCLUSIONS

Bronchography, by rendering visible the invisible, is an aid to the roentgenologist, and, by reason of its potential assistance, deserves more universal employment.

#### BIBLIOGRAPHY

- (1) SICARD, J. A., and FORESTIER, J.: General Method of Radiological Exploration with Iodized Oil. *Bull. et mém. Soc. méd. d. hôp. de Paris*, March 10, 1922, XLVI, 463.
- (2) ARMAND-DELILLE, P., and GELSTON, C. F.: The Diagnosis of Dilatation of the Bronchi in Children by Means of the Injection of Iodinized Oil. *Am. Jour. Dis. Child.*, November, 1924, XXVIII, 530.
- (3) IGLAER, SAMUEL: Use of Injected Iodized Oil in Roentgen-ray Diagnosis of Laryngeal, Tracheal, and Bronchopulmonary Conditions. *Jour. Am. Med. Assn.*, June 19, 1926, LXXXXVI, 1879.
- (4) SINGER, J. J.: Injection of Iodized Oil, 40 per Cent. *Arch. Surg.*, January, 1927, XIV.
- (5) BALLON, D. H., and H. C.: Pneumography. *Arch. Surg.*, January, 1927, XIV, 184.
- (6) HARTUNG, ADOLPH: Bronchiectasis: What the Use of Iodized Oil has Demonstrated Relative to Diagnosis by Ordinary Roentgen Examination. *Am. Jour. Roentgenol. and Rad. Ther.*, August, 1929, XXII, 120-127.
- (7) ERMATINGER, L. H.: Micro-organisms of Lung Abscess in Bronchiectasis. *Jour. Infect. Dis.*, November, 1928, XLIII, 391-398.
- (8) KAUFMANN, E.: Pathology, I, 1929, p. 351.
- (9) GRAWITZ, P.: Ueber Augeborene Bronchiectasis, *Arch. f. path. Anat.*, 1880, LXXX, 217-237.
- (10) STOERK, O.: Ueber Augeborene Blasige Missbildung der Lunge. *Wien. klin. Wchnschr.*, 1897, X, 24-30.
- (11) SAUERBRUCH: Chirurgie der Brustorgane, third ed., Berlin, 1920.
- (12) BLAZER and GRANDHOMME: Contribution à l'étude de la bronchopneumonia syphilitique du fœtus et du nouveau-né. *Rev. meus. d. mal. de l'enf.* Paris, 1886, IV, 485-506.
- (13) REYNAUD: Mémoire sur l'oblitération des bronches. *Mém. Acad. de med. Paris*, 1835, IV, 117-167.
- (14) CORRIGAN: Cirrhosis of the Lung. *Jour. Med. Soc. of Dublin*, 1835, XIII, 266-286.
- (15) RISI, E.: Les diagnostic differential la tuberculose et les affections des fosses nasales. *Presse Méd.*, July, 1916, XXXIV, 341.
- (16) WEBB, G. B., and GILBERT, G. B.: Bronchiectasis and Bronchitis Associated with Accessory Sinus Disease. *Jour. Am. Med. Assn.*, March 12, 1921, LXXVI, 714.
- (17) MULLIN, H. V.: The Accessory Sinuses as an Etiologic Factor in Bronchiectasis. *Am. Jour. Rhin. and Laryng.*, 1921, XXX, 683.
- (18) HEDBLOM, CARL A.: Pathogenesis, Diagnosis and Treatment of Bronchiectasis. *Surg., Gynec. and Obst.*, February, 1931, LII, 2 A, 406-417.
- (19) QUINN, L. H., and MYER, O. O.: Relationship of Sinusitis and Bronchiectasis. *Arch. Otolaryngol.*, August, 1929, X, 152-165.
- (20) ELOESSER, L.: Congenital Cystic Disease of the Lung. *RADIOLOGY*, November, 1931, XVII, 912-929.
- (21) ARCHIBALD, E. W.: Cited by B. H. Nichols in Lipiodol in Relation to Chest Diagnosis. *RADIOLOGY*, January, 1929, XII.
- (22) PRITCHARD, S., WHYTE, B., and GORDON, J. K. M.: Conclusions Regarding Technic Following 1,000 Intratracheal Injections of Iodized Oil in Adults. *RADIOLOGY*, February, 1927, VIII, 104-110.
- (23) OCHSNER, A., and NESBIT, W.: Bronchography: Introduction of Iodized Oil into Tracheobronchial Tree by "Passive" Method. *Am. Jour. Med. Sci.*, February, 1928, CLXXV, 175-184.
- (24) ARCHIBALD and BROWN: Dangers of Introduction of Iodized Oil into Tracheobronchial System. *Jour. Am. Med. Assn.*, April 23, 1927, LXXXVIII, 1310.

## EDITORIAL

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LEON J. MENVILLE, M.D. . . . . *Editor*  
BUNDY ALLEN, M.D. . . . . *Associate Editor*

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### CAN THE INTRAVENOUS INJECTION OF THORIUM DIOXIDE BE RECOMMENDED AS A SAFE DIAGNOSTIC AGENT?

The use of thorium dioxide as a diagnostic agent in the visualization of the reticulo-endothelial system extends over a period of several years. Its first demonstration in this regard was made in Europe, where it gained its greatest popularity, although a number of American radiologists reported with more or less enthusiasm having used thorium dioxide intravenously as a diagnostic agent. This method of examination, however, has not been generally accepted in this country, probably because it is not considered entirely free from danger when used intravenously to visualize the reticulo-endothelial system.

The principal reasons why the American radiologists have been reluctant in adopting the intravenous administration of thorium dioxide as a routine diagnostic measure has been that the organs of the reticulo-endothelial system readily absorb this substance and retain it for a period of months, probably for years, or perhaps a lifetime. Thorium dioxide contains thorium, an element belonging to the radio-active group, which is capable, according to some observers, of producing a definite biological effect

on tissue. It has been reported that an organ removed at postmortem, which had previously been made to absorb thorium by the intravenous injection of thorium dioxide, had the power of affecting a photographic plate when placed upon it. If all preparations of thorium dioxide in colloidal form have such radio-active properties, one can appreciate readily the damage they could do to organs of the reticulo-endothelial system in which they were retained for a period of months and perhaps years. It should be mentioned in this connection that certain observers have failed to confirm such findings. This discrepancy between the findings of various investigators is probably due to the fact that in one instance an old preparation of thorium was used and in the other a fresh one. It has been stated that the radio-activity of thorium in thorium dioxide increases with age. We must remember, therefore, that there may always exist a certain risk in using thorium dioxide undated. The manufacturer of a certain preparation of thorium dioxide (thorotrust) issues a caution to users of this preparation. He says:

"The clinical evidence to date indicates that thorotrust is a valuable contribution to roentgenography, and that no harmful effects may be expected following its use. We wish, however, to point out that the question as to the elimination of thorotrust from the body, following intravenous injection and subsequent storage in the reticulo-endothelial system, is still under investigation, and no definite and reliable evidence that could be accepted as conclusive has been published."

"Therefore, in accordance with our established conservative policy, we recommend to the profession further study on the ultimate

fate of the intravenously injected thorotrust before such injection is accepted as routine practice in the x-ray visualization of the liver and spleen, etc."

We wish to commend the splendid spirit of this manufacturer in warning the profession to be conservative in the use of this preparation as a routine measure until such time as further reports shall show the harmlessness of its use intravenously, and particularly in regard to its elimination.

It should be recalled that many of the most useful diagnostic and therapeutic agencies were not accepted and used by the medical profession until long after they had been announced, and only after careful studies were made in order to determine their practical application and also their toxicity.

We should not be too hasty in condemning any new diagnostic or therapeutic agent without sufficient and thorough investigation, but, on the other hand, we should be extremely cautious and careful in giving approval of such an agent for routine use until it has stood the acid test of the experienced radiologists. We do not believe that sufficient study has been made of the radioactivity of thorium dioxide on tissue to determine just what changes are brought about. Until this is thoroughly investigated by competent and efficient research workers, we could not recommend its use intravenously as a routine diagnostic measure. However, the subcutaneous injections to visualize the lymphatic system have been shown repeatedly to be free from any local or constitutional reaction, though it has been reported in one instance that marked changes were observed in a lymph node which had absorbed thorium. In many other similar nodes with thorium no such findings were observed. Therefore, there exists some doubt as to whether the changes just mentioned were the result of the absorbed thorium or due to other causes.

It is a great pity that thorium dioxide seems to have limitations as to its safety as a diagnostic agent. Its use has made possible the visualization of organs never before seen with the x-ray. Its potential diagnostic possibilities are almost beyond our conception. We have already seen in print its use as a diagnostic agent in retrograde pyelography; osteomyelography; pulmonealveography; nephrography; placentography; heptography; splenography. It has also been used subcutaneously, intraperitoneally, interpleurally, and interpericardially to visualize portions of the lymphatic system in laboratory animals without any noticeable ill effect. Subcutaneous and intraperitoneal injections have also been made on humans without any subjective or objective symptoms. In these injections the thorium dioxide was absorbed by the lymph vessels and did not reach the reticulo-endothelial system as it would have done had it been intravenous instead. It has long been known that particulate matter and colloidal substances are absorbed by the lymphatic system, while the soluble substances are absorbed by the vascular system when injected subcutaneously. This explains why the subcutaneous injection of thorium dioxide cannot be considered harmful to the organs of the reticulo-endothelial system.

We are in entire agreement with the recent preliminary report of the Council on Pharmacy and Chemistry of the American Medical Association in regard to thorotrust.

"In view, therefore, of the very imperfect elimination of thorium dioxide, its fairly high alpha-ray activity, the possibility of further increase in radio-activity by partial conversion to mesothorium and radiothorium and the possibility of sensitization of tissues to roentgen rays; considering the short period during which patients have been kept under observation, the Council voted that thorotrust be not accepted for *intravenous administration*." (*Jour. Am. Med. Assn.*, Dec. 24, 1932, XCIX, 2183-2185.)

## ANNOUNCEMENTS

### AMERICAN CONGRESS OF RADIOLOGY

#### OFFICERS OF THE CONGRESS

##### *President*

Henry K. Pancoast, M.D., Philadelphia

##### *Vice-presidents*

Albert Soilard, M.D., Los Angeles, President of American College of Radiology

Burton J. Lee, M.D., New York City, President American Radium Society

John T. Murphy, M.D., Toledo, Ohio, President American Roentgen Ray Society

Byron H. Jackson, M.D., Scranton, Pa., President Radiological Society of North America

#### EXECUTIVE COUNCIL

##### (organizing the Congress)

##### *Chairman of the Council*

Benjamin H. Orndoff, M.D., Chicago

##### *Secretary of the Council*

Edward L. Jenkinson, M.D., Chicago

##### *Treasurer of the Council*

Henry Schmitz, M.D., Chicago

Chairman, Committee on Publicity, James T. Case, M.D., Chicago.

Chairman, Committee on Local Arrangements, M. J. Hubeny, M.D., Chicago.

Chairman, Committee on History and Education, Byron H. Jackson, M.D., Scranton, Pa.

Chairman, Committee on Finance, Edward L. Jenkinson, M.D., Chicago.

Chairman, Committee on Scientific Exhibits, B. R. Kirklin, M.D., Rochester, Minn.

Co-chairmen, Committee on Publication, Lawrence Reynolds, M.D., Detroit, Mich., and Leon J. Menville, M.D., New Orleans, La.

Chairman, Committee on Commercial Exhibits, John T. Murphy, M.D., Toledo, Ohio.

Chairman, Committee on Scientific Pro-

gram, George E. Pfahler, M.D., Philadelphia.

Chairman, Committee on Travel and Transportation, Henry Schmitz, M.D., Chicago.

Chairman, Committee on Membership, Albert Soilard, M.D., Los Angeles, Calif.

*Place of Meeting*.—Palmer House, Chicago.

*Date of Meeting*.—September 25-30, 1933.

### AMERICAN CONGRESS OF RADIOLOGY

The Executive Council of the American Congress of Radiology, scheduled for the Palmer House, Chicago, September 25-30, inclusive, has written to as many radiologists in the United States and Canada as are listed in the headquarters office and to many in Central and South America and abroad, inviting them to attend the Congress. Every radiologist who has received the invitation is urged to send in immediately his photograph and information for the Congress album, a copy of which will be given to each member; and to send in his registration blank *filled out*, and his fee in connection, in order that he may become a member of the Congress and receive free a copy of the beautiful book "Science of Radiology," which is being prepared in connection with the Congress. All arrangements are being made by the local committee, and communications may be addressed to Benjamin H. Orndoff, M.D., Chairman, 2561 N. Clark Street, Chicago. Physicians and other scientists interested are invited to communicate with Dr. Orndoff.

It will be recalled that the four national radiological societies, the American College of Radiology, the American Radium Society, the American Roentgen Ray Society, and the Radiological Society of North America are meeting jointly this year and that the most comprehensive scientific pro-

gram ever given in the Americas is being prepared. Sessions will be held only until 2 p.m. each day, in order that the visiting physicians and scientists may attend the Century of Progress on the lake front. Ample accommodations will be arranged for at the Palmer House, Chicago, for all guests.

JAMES T. CASE, M.D.

*Chairman, Publicity Committee.*

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#### AMERICAN CONGRESS OF RADIOLOGY

##### A CENTURY OF PROGRESS

Chicago and its spectacular, fascinating "A Century of Progress," the finest extravaganza of achievement in a century, beckons invitingly to the hundreds of radiologists who will attend the American Congress of Radiology from September 25 to 30, inclusive, at the Palmer House, Chicago.

Eighty-two miles of exhibits, hundreds of stellar attractions in the realms of science, education, history, romance, fun, foods, music, thrills, and adventure comprise the Fair. Built on 424 acres of made land, stretching for three miles along the shore line of Lake Michigan, nestled almost in the shadows of the big loop skyscrapers, A Century of Progress has been the world's busiest spot since the opening day. And it is the world's most colorful spot by day, and the world's brightest spot by night.

Brilliant, though softly blending, blues, reds, greens, golds, bronzes, silvers, blacks and whites—twenty-five colors in all, have been employed by artists to give the grounds a blazing kaleidoscopic spectacle. At night, miles of neon tubes, carefully concealed indirect lighting, flood the great expanses of the buildings with varicolored lights. Spotlights, color fountains, and mushroom ground lights all add to the glory of the sight.

Telling the story of the growth of chemistry, physics, mathematics, geology, medicine, surgery, and pharmacy graphically, the

hundreds of exhibits in the Hall of Science are some of the most comprehensive at the Fair. Among other things, there are 60 physics exhibits; there is a \$10,000 "robot" who tells of the mechanical movements of his viscera by an illuminated "interior view" of himself. The earth sciences, appropriately epitomized by a "giant clock of the ages," are shown on the screen in the center of the dial, while the minute hand ticks off two billion years of earth history.

Exhibits in jewelry, cosmetics, office furniture, the graphic arts, mineral industries, and textiles are housed in the General Exhibits group, while the General Motors Building has a complete assembling plant for automobiles. Long miles of exhibits in the Hall of States tell the wonders of Alaskan fisheries, of Hawaii's amazing fruits, California's beauty, Illinois' products. All in all, more than thirty states present their stories in surprising detail. The United States Government Building stands in the center of the horseshoe formed by the Hall of States, and exhibits showing the strides made in the various branches of government in the last 100 years are to be found.

Illinois, as host State to the Nation, has erected the only State building at the Fair, and its "welcome house" tells, among other things, the story of Lincoln through the comprehensive collection of Lincolniana to be found in three of the Host Building rooms. Stained glass windows, made by the re-discovered ancient Phoenician process, picture colorfully Illinois scenes, history, and accomplishments. There is an auditorium where lectures are held from time to time, and the largest and most comfortable lounge in the Exposition takes up the entire south wing of the building.

Other feature attractions of the World's Fair are the exhibits of visiting nations, as Italy, Japan, China, Sweden, Czechoslovakia, Ukrainia, the beautiful reproduction of a Belgian Village, and others. The Hall

of Social Science telling the Story of Man, the Radio and Communication Building, the Electrical Building, and the Home Planning Group are all particularly interesting. And so are the Mayan Temple, Chrysler Building, Horticultural Building, Hall of Religion, Firestone Building, the Sky Ride, the Dairy and Agricultural buildings, Fort Dearborn, and the Alpine gardens.

#### FOURTH INTERNATIONAL CONGRESS OF RADIOLOGY

The Congress will be held in Zurich, under the presidency of Prof. H. R. Schinz, July 24 to 31, 1934.

According to Sect. 3 of the "Rules and Regulations" the Congress may be attended by: (1) Members of radiological societies in all countries; (2) persons introduced by such societies.

The 32 countries which were represented at the Third International Congress of Radiology in Paris have been invited by the Organizing Committee to appoint delegates to the International Committee and to nominate a speaker to report on the organization of the cancer campaign in his country at the opening session.

At the general meetings the following subjects will be treated:

- X-ray diagnosis of bone tumors
- Vasography
- The development of pulmonary tuberculosis as seen radiologically
- Radiation treatment of uterine carcinoma
- Radiation treatment of malignant tumors of the mouth and pharynx
- Radiation genetics
- Mitogenetic radiation
- Structure analysis
- Identical physical measurement of the dose in x-ray and radium treatment
- Hard gamma rays, cosmic radiation, earth radiation
- Short wave therapy
- In addition, the Sections for X-ray Diag-

nosis, Radiotherapy, Radiobiology, Radiophysics and Radiotechnic, Electrology and Heliotherapy will hold discussions and every member of the Congress is entitled to present a communication.

During the Congress an exhibition of apparatus, photographic accessories, chemical products, and scientific books will be on view. (For details apply to A. Strelin, Kilchberg, Zurich.)

All radiological societies are requested to send as soon as possible a list of their members to the General Secretary, Dr. H. E. Walther, Gloriastrasse 14, Zurich, Switzerland.

PROF. HANS R. SCHINZ, *President*

DR. RENÉ GILBERT, *Charge de Cours, Vice-president*

P.-D. DR. AD. LIECHTI, *Vice-president*

PROF. MAX LÜDIN, *Vice-president*

PROF. A. ROSSELET, *Vice-president*

DIRECTOR W. MERIAN, *Treasurer*

DR. HANS E. WALTER, *General Secretary*

*The Organizing Committee.*

#### WISCONSIN STATE MEDICAL SOCIETY

##### SECTION ON RADIOLOGY

The Ninth Annual Meeting of the Section on Radiology of the Wisconsin State Medical Society was held at Fond du Lac, Wisconsin, in the Retlaw Hotel, May 19 and 20, 1933. The Chairman was J. Newton Sisk, M.D., of Madison, Wis.

The meeting was one of the best this group has ever held—well attended by radiologists and clinicians from nearby towns. Janesville was selected for the next annual meeting, and the following officers were elected for the coming year: R. L. Troup, M.D., of Green Bay, *Chairman*; F. H. Kuegler, M.D., of Janesville, *Vice-chairman*; F. W. Mackoy, M.D., of Milwaukee, *Secre-*

*tary-Treasurer; J. E. Habbe, M.D., of Milwaukee, Member of Executive Committee.*

The active membership in this Section is composed of members of the Radiological Society of North America. This has been found to be a practical means of keeping the membership in the National Society intact.

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#### AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians will hold its Eighteenth Annual Clinical Session in Chicago, with headquarters at the Palmer House, April 16-20, 1934.

Announcement of these dates is made particularly with a view not only of apprising physicians generally of the meeting, but also to prevent conflicting dates with other societies that are now arranging their 1934 meetings.

George Morris Piersol, M.D., of Philadelphia, is President of the American College of Physicians, and will arrange the program of General Sessions. James B. Herrick, M.D., Emeritus Professor of Medicine of Rush Medical College, Chicago, has been appointed General Chairman of local arrangements and will be in charge of the program of Clinics. Mr. E. R. Loveland, Executive Secretary, 133-135 S. 36th Street, Philadelphia, Pa., is in charge of general and business arrangements, and may be addressed concerning any feature of the forthcoming session.

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#### MINNESOTA RADIOLOGICAL SOCIETY

The annual meeting of the Minnesota Radiological Society was held in Rochester, Minnesota, May 22, 1933, in conjunction with the annual meeting of the Minnesota State Medical Association. The following program was presented:

1. Radiation Therapy in Non-malignant Conditions. GAGE CLEMENT, M.D., of Duluth.

Discussion by: WILHELM STENSTROM, Ph.D., of Minneapolis.

2. Correlative Value of Clinical and Pathological Findings in Roentgenologic Diagnosis. KANO IKEDA, M.D., of St. Paul.

Discussion by: CHARLES G. SUTHERLAND, M.D., of Rochester.

3. The Place of the Roentgenologist in the Private Practice of Medicine. LEO G. RIGLER, M.D., of Minneapolis.

Discussion by: E. L. TUOHY, M.D., of Duluth.

4. Childhood Tuberculosis. R. G. ALLISON, M.D., of Minneapolis.

Discussion by: C. A. STEWART, M.D., of Minneapolis.

5. Round-table Conference: Roentgen Diagnostic Problems. Conducted by B. R. KIRKLIN, M.D., of Rochester.

The following officers were elected for the coming year: *President*, Edward Schons, M.D., of St. Paul; *Vice-president*, R. G. Allison, M.D., of Minneapolis; *Secretary-Treasurer*, L. G. Rigler, M.D., of Minneapolis.

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#### A WELL-KNOWN SOUTHERN EDITOR

The friends of Sidney C. Barrow, M.D., of Shreveport, La., are pleased to learn that he is Editor of the "Tri-State Medical Journal," the States sustaining it being Texas, Arkansas, and Louisiana.

Dr. Barrow has been a member of the Radiological Society of North America since the early days of the organization, and has been a Counselor for his State. Also, he is past president of the Louisiana State Medical Society, and is widely known throughout the South for his constructive work in general medicine and radiology. The "Tri-State Medical Journal" is to be congratulated upon securing Dr. Barrow for the Editorship.

## BOOK REVIEWS

DIE DICKDARMSCHLEIMHAUT, IHRE NORMALE UND PATHOLOGISCHE FUNKTION IM RÖNTGENBILDE. PRIV.-DOZ. DR. WERNER KNOTHE, Leiter der Röntgenabteilung der II. Medizinischen Universitätsklinik der Charité, Berlin (Direktor: Prof. G. v. Bergmann). Paper, 56 pages and 113 illustrations. Published by Georg Thieme, Leipzig, Germany, 1932. Price, 8 marks.

At the incitation of H. H. Berg, to whom greatest credit must be given for having brought the so-called internal relief roentgenology of the stomach and duodenum into the foreground, the author has undertaken to apply to the study of the mucosa of the large intestine, the same methods of investigation and principles of interpretation elaborated by Berg upon the groundwork of Forssell's pioneer observations. The mucosa of the alimentary tract is looked upon as meriting special attention and a special technic of investigation, not merely because the earliest as well as the most conspicuous macroscopic evidence of pathologic change is found there, but particularly because the mucosa itself is supposed to have a functional activity independent of the muscularis propria of the alimentary tract. Changes in this integral functional activity are alleged to be deducible from changes in the general appearance and arrangement of the mucosal folds. It is this latter point of view which is novel, for the importance of most careful scrutiny of the mucosal surface of all segments of the alimentary tract for evidence of organic change has always been realized by competent roentgenologists, though all of them have not insisted on roentgenographic data. The primary consideration in this monograph centers around the functional point of view. Almost half of the volume, however, is taken up with descriptive and illustrative material of true organic changes in the colonic mucosa as the method of diminished filling exhibits them.

The material is presented clearly and concisely, and there is a profusion of excellent illustrations. Dr. Knothe makes out a very good case for more widespread attention to the internal relief in the roentgenologic investi-

gation of the alimentary tract, particularly of the colon. Whether or not anything new in the way of roentgenologic signs or sign-complexes of organic disease will thus be forthcoming remains to be seen.

The method of diminished or incomplete filling should be looked upon, in the opinion of this reviewer, as a refinement of technic to complement and not to supersede older well established methods. It certainly has not made the roentgenologic diagnosis of gastro-intestinal disorders less complicated, and he who desires to set great diagnostic import upon minor changes in the mucosal relief will find a wide experience in the interpretation of these not uncomplicated mucosal manifestations of inestimable advantage.

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LE PNEUMOTHORAX BILATÉRAL SIMULTANÉ (PNEUMOTHORAX, BILATERAL, SIMULTANEOUS). By M. ASCOLI and M. LUCACER, Director and Assistant, respectively, of the Medical Clinic of the University of Palermo. Preface by F. DUMAREST. A volume of 104 pages, with 11 illustrations (Collection Médecine et Chirurgie pratiques, No. 54). Published by Masson et Cie., Paris, 1932. Price, 22 francs.

The authors present a monograph dealing with bilateral collapse therapy, reviewing the history of the indications for, and the technic of this procedure. It is stated that one of the authors proposed and applied the procedure whereby a pneumothorax was induced in the contralateral lung while the original pneumothorax was still effective, in collaboration with Fagioli in 1912, but no mention appears at this point, though included in the bibliography of Forlanini's work, published in 1911. As contra-indications they mention cachexia and advanced toxemias, diffuse lesions, cardiac lesions, and extra-pulmonary complications. Pulmonary perforation is more frequent than in unilateral pneumothorax. Bilateral simultaneous pneumothorax is a sanatorium or hospital procedure and but rarely to be employed in the ambulant case.

In an extensive bibliography the reviewer notes many important omissions from the

North American literature, though the authors have furnished a fairly complete bibliography of the Continental literature. The book is an excellent résumé and critique of a therapeutic procedure which has perhaps received insufficient attention.

**LES RÉVEILS DE LA TUBERCULOSE PULMONAIRE CHEZ L'ADULTE: CONDITIONS DE LEUR POLYMORPHISME ANATOMO-CLINIQUE** (The Awakening of Pulmonary Tuberculosis in the Adult). By PROF. ÉMILE SERGENT, Membre de l'Académie de Médecine. A volume of 228 pages, with 27 illustrations. Published by Masson et Cie., Paris, 1933. Price, 34 francs.

Tuberculosis is an awakening of a childhood inoculation which, insufficiently strong or virulent to lead to death, has left a definite imprint—the virgin soil has become the tuberculized soil. Clinical observation proves that in the majority of cases this awakening occurs

without any intervening new contamination. When it takes place it expresses itself by the most diverse anatomical-clinical manifestations of which the univocal nature is attested only by the presence of the specific germ. How is it that this germ, solely by its presence, is able to produce so variable processes? What other conditions are able to exercise their influence on the clinical-pathological picture? In an effort to answer these and allied questions the author has assembled in his monograph a series of lectures and articles which he and collaborators have published in recent years. The rôle of the terrain, the antebacillary phase, the idea of activation, the relation of asthma and tuberculosis, the propagation of cervical lymphatic tuberculosis furnish interesting chapters. For one who lacks the time or opportunity to follow the wealth of material in the French literature this volume will furnish an excellent résumé of the ideas of this author and his collaborators.

## ABSTRACTS OF CURRENT LITERATURE

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H. W. Hefke, M.D.  
Paul C. Hodges, M.D.  
E. T. Leddy, M.D.  
H. C. Ochsner, M.D.

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#### HEART AND VASCULAR SYSTEM (DIAGNOSIS)

Roentgen Sound Film. Berlin letter. Jour. Am. Med. Assn., April 1, 1933, C, 1049.

A German technical institute for music has a radio experimental station in which Grosse has produced a film in which he synchronized roentgen films with corresponding sound records. One sees, for example, the diaphragm and the heart of an athlete working in rhythmic agreement. The eye and the ear follow the motions and sound associated with articulated words. Even when a person is silent, the sounds of his heart will be caught by the transmitter and will furnish an accompaniment to the roentgen films showing the pumping activity of the heart.

Since heretofore heart sounds and murmurs have been reproduced without distortion by the methods of Dr. Jacobson, he has been endeavoring to make records suitable for instruction purposes, and secondly, to reproduce the heart sounds and the murmurs synchronously with the heart movements. From a number of single roentgen negatives, systole and diastole are selected and positives are prepared from them; the transitional movements between the two phases are represented artificially. Thus one procures a roentgen film of the heart action; by taking into account the time factors affecting heart action and the speed with which the film pictures are presented, one can figure out the number of "frames" required for the various phases. For the preparation of the individual frames, Jacobson has constructed a camera that represents a combination of photographic apparatus and cinema camera. The sound films that were first prepared and presented (a normal heart and a heart with aortic insufficiency, which in the roentgenogram shows a projecting left ventricle and aortic arch) were synchronized with the artificial heart sounds. These artificial sounds, presented a year ago, are especially suitable for a sound film because of their freedom from disturbing factors in connection with high amplification. For the purpose of synchronization, Jacobson uses an electrical cardiac tachometer, which has a device gauged according to the frequency of the heart beat and connected with the heart sound generator. In this manner the number of sounds or murmurs produced when the film is reeled off at a given speed is determined and thus a synchronism between the pictures and the sounds is produced. The didactic value of the new method is based on the simultaneous optical and acoustic record of the heart action under normal and pathologic conditions.

C. G. SUTHERLAND, M.D.

#### HEMOPHILIA

Hemophilia. Carroll LaFleur Birch. Jour. Am. Med. Assn., Nov. 5, 1932, XCIX, 1566-1572.

Hemophilia is usually classified under the hemorrhagic diatheses. The disease is manifested clinically by excessive hemorrhage, which may be spontaneous or may follow slight injury, and may occur any place in the body. Perhaps the most characteristic location of hemorrhage is into the joints. In the acute stage the joint is swollen, hot, and very painful; usually there is no discoloration. After repeated hemorrhages there is atrophy and proliferation of bone, roughening of the articular surfaces, with lipping, and osteophyte formation. In the chronic stage the appearance of the joints closely resembles that of proliferative arthritis. Hemorrhage into the epiphyseal line may interfere with nutrition and stunt the growth of the bone. Hemorrhage into the hip joint often leads to destruction of the head of the femur, with consequent shorten-

ing of the leg. Probably no one with high-grade hemophilia escapes crippling of the joints and bones. Hemophilia is the most highly hereditary of all hereditary diseases. Treatment has consisted of the administration of preparations of ovary. On the whole, the results have been satisfying.

C. G. SUTHERLAND, M.D.

#### HODGKIN'S DISEASE (THERAPY)

Radiotherapy for Hodgkin's Disease and Lymphosarcoma. Arthur U. Desjardins. *Jour. Am. Med. Assn.*, Oct. 8, 1932, XCIX, 1231-1236.

The clinician can seldom distinguish one condition from the other. Mallory collectively designated this group of diseases by the term "lymphoblastoma." The pathologic features are often far from characteristic, absolute differentiation being difficult or impossible. As a diagnostic measure the radiotherapeutic test is often invaluable.

The only effective method of treatment is radiotherapy and irradiation by means of the roentgen ray, which has many advantages over radium. It is often advisable to irradiate many different areas. Lymphocytes are the most radiosensitive of all cells, and rays of medium wave length are more useful in the long run. Another important reason against short wave length rays as a routine is that blood supply may be seriously injured in cases in which many areas must be irradiated.

Roentgen treatment may be given by one or two methods. Irradiation may be confined to regions in which enlarged nodes are palpable or more general at the outset and later restricted to regions in which fresh lymphadenopathy appears. The latter is the better plan.

C. G. SUTHERLAND, M.D.

#### LIGHT THERAPY

A New Method of Light Therapy in Tuberculosis of the Larynx. A. J. Cemach. *Strahlentherapie*, March 9, 1932, XLIII, 547-564.

The author describes in detail a special quartz mercury vapor lamp which can be inserted into the larynx and which is especially suitable for the treatment of tuberculosis. The indication and prognosis in this type of case are related, followed by a discussion of the effect of the light on the pathologic process. General therapy is important as a supplement to the local irradiation.

ERNST A. POHLE, M.D., Ph.D.

#### NEVI

The Irradiation Treatment of Red Birthmarks: Experiences in Over 200 Cases. Ernst Kromayer. *Urol. and Cutan. Rev.*, August, 1932, XXXVI, 524-527.

The author, who has been treating red birth-

marks by irradiation with roentgen rays, radium, and light rays since 1906, discusses his experiences in the three anatomic types of this condition.

Red birthmarks may be arterial, capillary, or venous in origin. Arterial nevi are frequently not present at birth but appear during the first weeks of life as red points which grow to the size of a coin and present a light red protuberant surface. Capillary nevi are usually smooth and flat, but sometimes are protuberant. Among the flat nevi may be differentiated superficial ones, lying in or under the papillary body, and deep ones involving the whole thickness of the cutis propria down to the subcutaneous tissue. Venous birthmarks arise either from the papillary body or from the subcutaneous tissue and consist of dilated capillaries and veins lying in a soft, sparse connective tissue.

In the light irradiation treatment the author employs the blue light of the water-cooled Kromayer lamp, with careful compression of the skin by massive quartz layers. The maximum exposure is one-half hour, and, since the pain from the exposure develops the next day, it is considered advisable to treat the skin areas as a whole, whenever possible.

The dosage of roentgen rays and radium is one erythema dose, divided into six doses, each one-sixth S.E.D. administered on consecutive days. In small children, from 2 months to 2 years old, the irradiation dose of light, roentgen rays, and radium is decreased to one-third, one-half, or four-fifths of the adult dose.

In the treatment of arterial nevi radium is the method of choice, for not only are the superficial vessels acted upon but also those penetrating through the cutis. While one course is usually sufficient, in some cases the irradiation may have to be repeated after an interval of one month to prevent a recurrence of the nevus. Small nevi may be successfully removed by the cautery tip, but in the case of larger nevi, an arteriole may be overlooked and a recurrence would result. An additional disadvantage, especially in children, is that the application of the cautery point is painful. While the results of light treatment may cause an almost complete disappearance of the nevus, after subsidence of the inflammatory reaction, individual red points (which are the small arterioles) are noted in the irradiated area, these, in the course of weeks, increasing rapidly in size. The roentgen ray acts similarly though not as effectively as radium, and cannot be applied so conveniently.

Superficial capillary nevi are easily destroyed by a single intensive compression-irradiation with the blue light of the Kromayer lamp. However, usually, in one of the larger nevi there is involvement of the deeper vascular, as well as superficial, parts. The author therefore advises the primary irradiation with the blue-light compression treatment to be followed in from two to three weeks later by an erythema dose of radium, divided into six consecutive days.

In some cases even this form of therapy is unsatisfactory, for the vessels of the nevus are only slightly diminished.

Small superficial venous nevi can be removed by operation, corrosion, cold, electrolysis, and alcohol injection, and by roentgen or radium irradiation. Since irradiation is painless, it is preferred to the other forms of therapy. In the treatment of extensive and deep-seated venous nevi, roentgen and radium irradiation are the methods of choice, and in some cases the only possible method of treatment.

J. N. ANÉ, M.D.

### THE PELVIS

Contribution to the Roentgenologic Measurement of the Pelvis and Fetal Head *in Utero*. S. Ribbing. *Acta Radiologica*, 1932, XIII, Fasc. 5, pp. 591-598.

In pelvimetry one is concerned with the size and shape of the pelvis and the fetal head. The conjugata vera lies in the plane of a line connecting the upper border of symphysis and the spinous process of the fifth lumbar vertebra. One may measure this distance on a film of the pelvis made with the patient in a half-sitting posture. A perforated metal plate placed in the same plane as the conjugate, may be used or the patient may be placed so that this plane is parallel with the film, allowing for the distortion.

The conjugata vera may be measured even more accurately on a lateral film made by the Guthman method. This film also gives an excellent idea of the shape of the pelvis. It is probably advisable to make both the anteroposterior and lateral films in each case. Such a procedure is much simpler than the stereoscopic methods by which the pelvic measurements are estimated.

The author believes that the simplest method of measuring the transverse diameter of the pelvis is orthodiography by the Moritz method. This can be done with the patient lying on her back. The author uses a small metal ring fastened directly in line with the focal spot on the aluminum filter and a small diaphragm; he adjusts the end point of the transverse diameter to coincide exactly with the center of the metal ring and obtains in this way, on one film, two small pictures which coincide exactly with the two end points of the desired diameter. The cassette is held throughout the examination in exactly the same level above the patient's pelvis.

The irregular shape of the fetal head and the fact that its distance from the film is not known make accurate measurement of the head difficult. The author advises orthodiography for the measurement of the head also.

A. L. HART, M.D.

### PEPTIC ULCER (THERAPY)

The Relation of Alkalosis to Peptic Ulcer. Henry A. Rafsky, Louis Schwartz, and Alexander W.

Kruger. *Jour. Am. Med. Assn.*, Nov. 5, 1932, XCIX, 1582-1586.

Excessive doses of alkalies were administered to 61 patients with peptic ulcer, by a method in which initial small doses were followed by progressively larger doses until there ensued a complete cessation of symptoms. The carbon dioxide combining power of the blood plasma and blood chlorides did not reveal any evidence of alkalosis in any of these cases. Patients with renal disease, also allergic persons, were treated more cautiously by this method. Patients with pyloric obstruction and extreme degrees of gastric hypotonia were not treated by this plan. Two patients, treated according to the Sippy method, developed severe symptoms of alkalosis and showed definite biochemical changes. In order to minimize the danger of alkalosis resulting from excessive alkaline therapy, more attention should be directed to the method of administration as well as to the type of patient to receive this form of therapy.

C. G. SUTHERLAND, M.D.

### RADIATION

The Influence of Thorium X on Human Leukocyte Cultures, with Particular Consideration of the Effect of Benzol. G. Wallbach. *Strahlentherapie*, 1933, XLVI, 675.

After cultures of human leukocytes were exposed to thorium X the author observed a marked inhibition of the migration and growth of the various cell elements. In some cases cell death occurred, particularly among the granulocytes and to some extent among the lymphocytes. There seems to be a definite relation between dose and effect. The observed changes were undoubtedly due to the radiation emitted by thorium X. When compared with the effect of benzol on the same cell cultures, a marked difference was seen between the changes due to benzol and to thorium X.

ERNST A. POHLE, M.D., Ph.D.

The Effect of Roentgen Rays on the Carbohydrate Metabolism of Normal Animal Tissues. T. Ullmann. *Strahlentherapie*, 1933, XLVI, 705.

The testicles of rats and the liver of guinea pigs were exposed to roentgen rays by carefully shielding the remaining part of the body (135 K.V., 3 mm. Al; 600 r and 1,200 r). The glycogen content of irradiated rat testicles was about 58 per cent lower than in non-irradiated testicles. The glycogen cleavage in irradiated liver was definitely lower than in non-irradiated liver. The author assumes that these observations may be explained primarily by changes in the cell structure.

ERNST A. POHLE, M.D., Ph.D.

## RADIATION INJURIES

Studies as to the Indications and the Results of Treatment with Small Doses of and Temporary Sterilization by Roentgen Rays: Its Significance for the Offspring: Based on the Clinical Material of the Women's Clinic, University of Freiburg. D. Jost. Strahlentherapie, 1933, XLVI, 601.

The author analyzes 141 cases treated during 1919-1928 for abnormalities of menstruation. Included in the group were also pelvic inflammatory disease and uterine fibroids. Small doses of from 6 to 10 per cent H.E.D. (measured on the skin) produced 50 per cent cures in 36 cases of amenorrhea. Out of 23 cases of oligo- and hypomenorrhea, 54 per cent were benefited. Out of 17 cases of menorrhagia, 35 per cent responded well. Out of 13 cases of adnexitis, 5 were benefited. Four out of six patients with dysmenorrhea were improved. Two patients who complained of sterility were also treated: In one case a pregnancy occurred four months after treatment; in the other there was no benefit. Temporary sterilization was used only in cases of menorrhagia, adnexitis, and uterine fibroid. It was impossible to foretell the duration of amenorrhea from the applied dose. Some patients who did not receive the sterilization dose but much less, had permanent amenorrhea; with others, it lasted from eight weeks to eight years. In one case 25 per cent of the H.E.D. effective in the ovaries did not produce amenorrhea.

Very interesting was the follow-up of the treated cases: 37 had pregnancies, with 48 deliveries and 15 abortions. Of the 48 children, two were stillborn; 3 children died during the first year. One of these had celiac disease which might have been due to a radiation injury. Of the 43 surviving children, one presented delayed development, not learning to talk until the age of three and a half years.

The application of small doses of roentgen rays to the ovaries of women during the child-bearing period is, therefore, not recommended.

ERNST A. POHLE, M.D., Ph.D.

A Case of Injury to the Offspring Due to Roentgen Rays. Stefan Biró. Strahlentherapie, 1932, XLV, 549-552.

The author reports a case of a woman 32 years old who received x-ray therapy over the lower pelvis because of irregular menstruation. Pelvic examination three months later led to the diagnosis of a uterine tumor. Because of the possibility of an ectopic pregnancy in a uterus arcuatus, the patient was admitted to the hospital three months after this examination. A child 39 cm. long, weighing 1,550 grams, was born, with a head circumference of 25 centimeters. Although the child gained in weight the author believes that the microcephaly was due to the irradiation carried out during the mother's pregnancy.

ERNST A. POHLE, M.D., Ph.D.

The Occurrence of Roentgen Pleuropneumonitis in Treatment of Breast Cancer. R. H. Fike. Am. Jour. Roentgenol. and Rad. Therapy, April, 1932, XXVII, 509-512.

The term "roentgen pleuropneumonitis" is used to describe all undesirable radiation effects in the chest wall, pleura, and lungs. Clinically the condition is characterized by a harsh, unproductive cough, with varying degrees of dyspnea. Roentgenologically the condition resembles the early stage of massive collapse, the diaphragm on the affected side being elevated and fixed, the mediastinal contents displaced toward the involved side, and the entire lung field hazy. Later the haziness clears up and a varying degree of fibrosis can be recognized.

On reviewing the case records of 670 patients who had received deep therapy to the extent of 4,170 treatments over the thorax, no cases of clinical roentgen pleuropneumonitis developed; however, two cases receiving repeated irradiation and later coming to necropsy showed microscopically adhesions between the lung and pleura under the area treated and distinct atelectasis in the adherent portion of the lung, the alveoli being compressed and the walls thickened and swollen. No massive connective tissue proliferation or changes in the smaller bronchi were noted. A case is also presented of a patient who had had repeated superficial radiation over both sides of the chest and who one year later showed the roentgen picture of right-sided pleuropneumonitis but whose clinical symptoms were relatively slight.

J. E. HABBE, M.D.

## RADIAUM (THERAPY)

Treatment of Malignant Tumors: Advantages of Weak Heavily Filtered Radium Needles. Charles L. Martin. Jour. Am. Med. Assn., Nov. 5, 1932, XCIX, 1587-1592.

Certain tumors, such as lymphosarcomas and masses of leukemic glands, may be melted away rapidly by irradiation. Other forms, such as adenocarcinomas, respond less rapidly. Normal tissues vary in their reaction to irradiation just as do malignant cells. The problem involved in safely eradicating only the abnormal structures becomes difficult in the deeper parts of the body. Irradiation of great penetrating power and short wave length has much less necrotizing effect and a greater selectivity for radiosensitive cells than irradiation of less penetrating power and shorter wave length. The selectivity of radiant energy for radiosensitive cells is increased when the duration of the exposure is increased, with a corresponding decrease in intensity. Regaud put these principles into practice by preparing long, heavily filtered, platinum needles containing small amounts of radium for use in implantation therapy. The low intensity needles have been used success-

fully in many locations—mouth, breast, rectum, prostate, vulva, vagina, cervix, urethra, and larynx. The rapid regression of malignant tumors and the rapid healing that follows their regression are strong arguments for this method. Roentgenograms made following implantation reveal errors of distribution which may be easily corrected. The trend toward higher voltages and heavier filters in roentgen therapy is based on the principles laid down in this paper, and it is to be hoped the results obtained will be as satisfactory as those observed following the changes in radium technic.

C. G. SUTHERLAND, M.D.

Radium Therapy of Nasopharyngeal Fibromas. Angelo S. D'Emidio. *Archivio di Radiologia*, Sept.-Dec., 1932, p. 789-795.

The author reports two cases treated by him, both recurrences, and in both of which a good and lasting result was obtained. He advises direct application through the nasopharynx of heavily filtered radium, giving a dose of from 20 to 30 mc. in about ten days. He feels that radium therapy is superior both to operation and diathermy.

E. T. LEDDY, M.D.

#### ROENTGEN RAY (INDUSTRIAL APPLICATION)

The Decomposition of Benzophenondiazid and a Few Other Nitrogen Compounds under the Influence of Roentgen Rays. G. Cronheim, S. Goetzky, and Paul Günther. *Strahlentherapie*, Feb. 10, 1932, XLIII, 379-389.

Benzophenondiazid gives off nitrogen when exposed to roentgen rays of various wave length. In the range of 0.6 to 1.54 Å, Glocker's theory concerning the chemical effect of roentgen rays was confirmed. This means that only that part of the radiant energy transformed into secondary electrons is responsible for the chemical reaction. In order to free one mol of nitrogen, 25,000 calories of secondary electrons are necessary for the range of wave length mentioned above.

ERNST A. POHLE, M.D., Ph.D.

#### THE SKIN (THERAPY)

The Effect of Combined Ultra-violet and Roentgen Radiation on the Skin. Lorenzi Angelo. *Archivio di Radiologia*, March-April, 1932, VIII, 273-280.

The author tested the effects of various combinations of ultra-violet and x-rays on the skin and found that excessive erythemas were produced. He, therefore, feels that any area which has had recent ultra-violet treatment should be irradiated with roentgen rays, exercising great caution.

E. T. LEDDY, M.D.

#### THE THYMUS (DIAGNOSIS)

The Thymus and its Function. Editorial, *Jour. Am. Med. Assn.*, Nov. 19, 1932, XCIX, 1782, 1783.

The functions are still a mystery—its anatomy is controversial. Generally, it is believed the gland is in some way correlated with the process of growth and that after puberty it undergoes a gradual atrophy and involution. There is also presumed to be some reciprocal relation between the thymus and the reproductive glands. Klose and Vogt hold that the thymus is concerned especially in the synthesis of nucleic acid. Hammar concludes that the variations in the lymphocytic content of the thymus and the variations in the Hassall corpuscles constitute the essential morphologic changes associated with thymic function. Every theory as to the physiology of the thymus must explain these histologic changes. There is apparently an increase in the development of Hassall corpuscles in various toxic conditions except intoxication by drugs. Since the thymus is essentially an epithelial organ filled with leukocytes, Hammar thinks it exerts an antitoxic action against certain poisons, and suggests the Hassall corpuscles are the morphologic exponents of this antitoxic function. In thymic death, he studied the gland and concluded the thymus was not directly concerned. The apparently large size of the gland was due to the absence of accidental involution. Bastienie concludes that the Hassall corpuscles are not organs of internal secretion; they merely phagocytize the thymic chromatin that has disintegrated. Various alterations and diseases, such as trauma, operative shock, and acute infections, seemed to induce a rapid, massive disintegration of thymic cells and the appearance of numerous young Hassall corpuscles. Starvation and chronic infectious diseases provoked a relatively slow thymic involution of the sclerotic type found in inanition. Diseases accompanied by starvation seemed to offer the best conditions for the gradual involution of the thymus, associated with "epithelial reversions." In two cases of exophthalmic goiter the thymus gland showed a hyperplasia due to accumulation of thymic cells and evidence of a recent crisis of nuclear disintegration. The disappearance of thymic cells in the course of pathologic involution is not due to their emigration but to their destruction *in situ*. The development of Hassall corpuscles is linked with the destruction of the thermocytes. Involution of the thymus is a simple reaction occurring in any involvement of the general condition and is not due to any particular disease or intoxication. He found no basis for the theory that the thymus develops an antitoxic secretion but he does find evidence in favor of the nuclein regulation theory. In the course of pathologic involution as well as in physiologic involution the thymus shows the same reactions of thymoclasia.

Grégoire has studied the effects of x-rays on the thymus in adults and in embryos, particularly from

the point of view of radiosensitivity of the small thymic cells, the nature of the phagocytic process, and the mechanism of reparation. One school believes the thymic cells are formed by the immigration of leukocytes into the thymus, the other urges that the large epithelial cells are the ancestors of the small thymic cells. Grégoire concludes the small thymic cells develop from the primitive epithelial cells within the thymus and that there is no immigration of exogenous cells. This transformation occurs through a type of diminutive mitosis especially characteristic of the thymus (classosis) first described by Dustin. The appearance of radiosensitivity in the small thymic cells of the embryo corresponds with the stage of diminutive mitosis which gives origin to the small thymic cells. X-rays selectively destroy the small thymic cells on their appearance. Grégoire reports that pregnancy induces in the thymus a transient reversible involution in an organ already undergoing physiologic involution more or less pronounced according to the age.

In the embryo as well as in the adult, this investigator observed tissue continuity between the thymus and the parathyroid glands, as well as the direct formation of parathyroid tissues at the expense of thymus epithelial cells. He has also called attention to the absence of Kurloff bodies in the thymus cells of the normal embryo. They were observed in considerable numbers in the thymus of the pregnant animal after irradiation. The Kurloff bodies are merely degenerative figures. Cellular metaplasia is a phenomenon peculiar to the thymus and is produced by frequent changes in the cortical region, and by the absence of a pathway for the elimination of cellular débris.

C. G. SUTHERLAND, M.D.

#### TUBERCULOSIS (DIAGNOSIS)

Atelectasis in Pulmonary Tuberculosis. Barnet P. Stivelman. *Jour. Am. Med. Assn.*, Nov. 12, 1932, XCIX, 1666-1670.

Experimental work has brought forth incontrovertible proof that the determining cause of atelectasis in any pulmonary area is the complete obstruction of its draining bronchus. Bronchoconstrictor reflex, diaphragmatic paralysis, and the vasomotor reflex have no etiologic relation to atelectasis.

Contributory factors are an accumulation of viscous secretion in the bronchial tree (most important); inflammatory processes in the smaller or larger bronchi; interference with the function of the ciliated epithelium; pain either in the chest or in the abdomen restricting the respiratory effort, and the need of narcotics to relieve the pain which abolishes the cough reflex. Atelectasis may result from pressure of lymph nodes on the bronchi. Multilobular or massive atelectasis of the lung in phthisis is uncommon. The acute form is best seen in patients with hemoptysis in whom a large blood clot may

occlude a bronchus. In chronic massive atelectasis reliable data are not available to show whether this providential atelectasis and the subsequent cirrhosis are due to an old primary plugging of the main bronchus or to multiple lobular atelectasis which has slowly progressed so as ultimately to involve the larger and main bronchi. Massive atelectasis of the lung in phthisis is most often confounded with extensive unilateral fibrosis. The roentgenologist is in no position to make a diagnosis of the underlying pulmonary process in cases of this type, and should not be asked to do so.

Lobular or confluent lobular atelectasis is of the most frequent occurrence in all stages of pulmonary tuberculosis. The narrowing of the interspaces at the site of the lesion, the deviation of the mediastinum toward the lesion, and the elevation of the homolateral leaf of the diaphragm in early cases are not due to fibrosis (of slow evolution), as has been hitherto supposed, but to lobular atelectasis, which develops with great rapidity in any tuberculous pulmonary area. The greater frequency of lobular or confluent lobular atelectasis in pulmonary tuberculosis appears to indicate that it is one of Nature's ways of initiating fibrosis in the involved area.

Lobar multilobular atelectasis in the course of artificial pneumothorax is apparently a beneficial process and leads to a better collapse and early fibrosis of the treated lung.

C. G. SUTHERLAND, M.D.

#### TUBERCULOSIS (THERAPY)

The Treatment of Tuberculosis of the Female Genital Organs. F. Gál. *Strahlentherapie*, 1933, XLVI, 617.

During the last ten years the author has seen 53 cases of tuberculosis of the female genital organs. Those treated by roentgen rays received through 0.5 mm. Zn at 30 cm. F.S.D. about 25 per cent H.E.D. per area (four fields over the abdomen). Forty-two patients were treated surgically and 13 received irradiation. In 11 of these 13 cases, the diagnosis was verified by laparotomy. Nine patients could be followed up for a period of from one to four years. One died from general tuberculosis one year after the treatment, while all the others remained well. In addition to the x-ray treatment, ultra-violet therapy was used. In the author's opinion, it is difficult, however, to evaluate the influence of ultra-violet rays on this disease.

ERNST A. POHLE, M.D., Ph.D.

The Question of Roentgen Therapy in Tuberculosis of the Female Genital Organs. H. Dworzak. *Strahlentherapie*, 1933, XLVI, 633.

The author briefly discusses the status of roentgen therapy in pelvic tuberculosis in women. He then reports one case in which a histologic examination of the organs was carried out after irradiation. The

woman, 22 years of age, was admitted with a histologically proven case of tuberculosis of the cervical os. She received 9 x-ray treatments between June, 1931, and March, 1932. The fields were applied over the anterior abdomen or the vulva, 110-200 r each time. At the end of that period the general condition was excellent but locally there was still evidence of the disease. Hysterectomy was, therefore, performed in June, 1932. A photograph of the specimen and photomicrograms of the sections are shown. The disease had partly healed and beyond a certain zone there was definite active tuberculosis. Six months later the patient returned with a recurrence in the stump of the vagina. This is being treated now by roentgen rays. The author concludes that neither irradiation nor surgery produced a complete cure in this case.

ERNST A. POHLE, M.D., Ph.D.

Liver Meal in the Treatment of Amyloidosis in Surgical Tuberculosis. Brainerd H. Whitbeck. *Jour. Bone and Joint Surg.*, January, 1932, XIV, 85-92.

Because liver meal administered to combat the anemia of chronic tuberculosis appeared to have a favorable influence upon amyloid degeneration of the liver and spleen, it has been used in the Neponsit Beach Hospital in the treatment of seven cases of amyloidosis.

Concentrated powdered whole liver was used in doses of 4 grams three times a day. One child died of pulmonary lesions early in the course of treatment; a second, after showing evidence of resorption of amyloid material, died (possibly from portal obstruction, there being no autopsy). The remaining five have been treated for two years and though a positive Congo red test persists, indicating that much amyloid material remains in the body, still the liver and spleen are smaller, ascites and venous distention have disappeared, and the general condition of the patients is frankly improved.

PAUL C. HODGES, M.D.

### TUMORS (DIAGNOSIS)

Tumors of the Adrenal Gland: Report of Two Cases of Paraganglioma of the Adrenal Gland. Joseph A. Lazarus and A. A. Eisenberg. *Jour. Urol.*, January, 1932, XXVII, 1-26.

Tumors of the adrenal are classified and described as indicated by a general survey of the literature. These tumors are rare. The most important growths from a clinical and pathologic viewpoint are those arising from the epithelial component of the gland.

The outstanding features of the tumors involving the adrenal cortex are the associated sex changes which have been designated as the adrenal-genital syndrome, and are most frequently seen in female children.

As a result of the fact that the adrenal medulla

is an offshoot of the sympathetic nervous system, tumors arising from this part of the gland bear a very close resemblance to tumors of the sympathetic system; and, the degree of malignancy shown by these newgrowths varies inversely with the state of maturity of the medullary cells. The more mature the cells, the more benign the growth.

Paraganglioma is a tumor composed entirely of mature chromaffin cells of the adrenal medulla, is usually benign, and unlike all other adrenal tumors occurs only in adults.

Adrenal tumors have a tendency to cause irreducible renal ptosis.

Fever and skin pigmentation are suggestive symptoms.

The finding of a large ovoid shadow in the roentgen plate situated over a psoas and rotated kidney is suggestive of an adrenal tumor.

The authors present two cases of paragangliomas, both of which occurred in women 58 years of age. The x-ray films in one of them led to a tentative diagnosis of an adrenal cyst, while in the other, the presence of the paraganglioma was clinically overshadowed by the co-existing carcinoma of the thyroid and was discovered only at autopsy.

A review of the literature seems to show that the second case is the only one on record of a paraganglioma metastasizing in other organs, thereby indicating that this tumor possesses potentially malignant properties.

A rather complete bibliography of this type of tumor accompanies the article, together with microscopic sections and roentgenograms of the two cases reported.

DAVIS H. PARDOLL, M.D.

Roentgenology as an Aid in the Diagnosis and Localization of Brain Tumors. B. A. Moxness. *Med. Bull. Veterans' Administration*, February, 1932, VIII, 99-104.

The author discusses the value of roentgenology as an aid in the diagnosis and localization of brain tumors, and agrees with Holmes that roentgenology of the skull, its contents, and adjacent structures constitutes a special field in the practice of radiology.

The statistics of Cushing's Clinic showed that of a total of 1,146 verified intracranial tumors, four main classes made up 88 per cent of the cases. Of these four groups, an average of 37 per cent were localized by the x-ray. Gliomas constituted 43 per cent of the series, and of these, from 10 to 12 per cent were recognized by the x-ray, due to calcification within the tumor. The pituitary tumors, which comprised 24 per cent of the series, occurred as common adenomas and the less common congenital cysts, arising from the remnants of Rathke's pouch. Of the third group of meningiomas, which constituted 12 per cent of the cases, 50 per cent were identified and localized on roentgenograms. The fourth

group, the neurinomas or neuromas of the acoustic nerve, comprised 9 per cent of the series.

The roentgen findings in brain tumors depend upon the size, type, and location of the tumor. The author believes that co-operation between the roentgenologist and clinician is of the greatest importance. Stereoscopic films in the lateral position of both sides of the head and antero-posterior views should be made. Roentgenograms made with the technic of Pancoast, by flexing the head on the body so as to incline it on the film holder 20 degrees, and directing the incident ray vertically downward, are of value in studying the middle and posterior fossæ, including the petrous bones. A well qualified roentgenologist who knows the normal and the variations from the normal anatomy of the skull is essential.

The adenomas of the sellar group of tumors produce an alteration in size and shape of the sella turcica as demonstrated in 90.8 per cent of tumors studied by J. Gershon-Cohen. The dorsum sella as a rule remains intact, although thinning or even fracture may occur. The depth rather than the antero-posterior diameter is first increased in the early stages. Some pituitary tumors tend to grow laterally and do not produce changes in the sella turcica. A pituitary carcinoma may erode any portion of the sella or may invade the sphenoid sinus. Increase in intracranial pressure does not occur until the pituitary tumor has enlarged sufficiently to obstruct the third ventricle.

The roentgen findings of cerebral tumors may be divided into direct and indirect signs. The direct roentgen signs are as follows: Calcification within the tumor; localized bone atrophy; localized bone hyperostosis, usually seen as a result of meningiomas and due to spicule formation following dilatation of the blood vessels and bone destruction. This hyperostosis may resemble an osteogenic type of sarcoma.

The indirect signs of cerebral tumors, resulting from increased intracranial pressure, are of more value in the diagnosis of gliomas. Convolutional atrophy, changes in the dorsum sellæ, increased prominence of the diploë vessels, widened arterial grooves, and separation of the sutures in young children indicate increase in the intracranial pressure.

Cerebellar, angle, and posterior fossæ tumors are best studied on roentgenograms made by the technic of Pancoast. The indirect signs which aid in the diagnosis of tumors of this group are as follows: Increased convolutional markings, which occur three times as often in this type of tumor as in cerebral types; atrophy of the dorsum sellæ; displacement of the pineal shadow.

The author is of the opinion that encephalography and ventriculography should not be employed until the patient has been carefully and thoroughly studied neurologically and roentgenologically. If such

a complete examination fails to reveal the presence of an intracranial tumor, then encephalography and ventriculography should be resorted to. Encephalography is contra-indicated in cases in which the spinal-fluid pressure is greater than 20 mm. of mercury in the reclining position. Ventriculography requires an operative trephine of the skull, and has greater risk attached to it, but it displays the ventricular system better than does encephalography.

J. N. ANÉ, M.D.

Roentgenologic Manifestations of Giant-cell Tumor. B. R. Kirklin and Claude Moore. *Am. Jour. Roentgenol. and Rad. Ther.*, August, 1932, XXVIII, 145-150.

For the 20-year period ending in 1929, 110 cases of giant-cell tumor were observed at the Mayo Clinic, 86 of these being proven by either operation or biopsy. In this group, two roentgenologic types were encountered with about equal frequency. One group was characterized by a trabeculated, cystic expansion of the end of a long bone, the cortex being intact, while the other group was commonly in the same location but showed a more homogeneous and complete lysis of bone and the cortex often broken through and partially destroyed. The pathologic changes grossly were as might be expected from the roentgen appearance, the second group showing a tumor space filled with a fluid, gelatinous mass of softer consistency than the tumor tissue, the x-ray appearance of which was characterized by trabeculation. Microscopically, however, the picture was the same.

It is suggested by the writers that the second group may represent merely a later stage of the more commonly observed and described lesion. It is important to differentiate the second type from primary sarcoma or massive metastatic tumor.

J. E. HARRE, M.D.

Ulcer in a Thoracic Stomach: Very Small Benign Gastric Tumors: Lymphogranulomatosis of the Stomach: Unusual Prestenotic Appearance of the Small Intestine: Lipomas of the Colon. Theodor Bársány and Ernst Koppenstein. *Röntgenpraxis*, October, 1932, IV, 818-828.

A thoracic stomach is a rare condition, but is readily demonstrable by roentgen examination. An ulcer in it is exceedingly difficult to find. Three cases have been described, to which the authors add another. In their case, in that portion of the stomach which was compressed by the spine when the roentgenogram was taken, a niche was evident. The patient's symptoms were mostly due to the ulcer, inasmuch as most of them disappeared after the institution of an ulcer régime.

Since introduction of the relief examination of the gastric mucosa, small benign gastric tumors are rarities no more. The decision between small benign

and malignant growths can often be made only after repeated examinations, with intervals of time between. In one case described, the sharply limited, small filling defect remained of the same size during four years, which proved its benign nature.

Two cases of gastric lymphogranulomatosis (Hodgkin's disease) are described, in one of which surgery proved the correctness of the diagnosis. Roentgenologically it presents the same appearance as a cancer and cannot be differentiated from it. In young individuals with a cancer-like roentgen appearance of the stomach, one should think also of syphilis and Hodgkin's disease, especially when, as in this case, the gastric acidity was found to be normal.

An interesting appearance of the prestenotic small intestine is described. A flat film showed fluid levels with gas distention of portions of the ileum. When a small amount of barium had been given, some small intestinal loops were found to be distended and presented an unusual honeycomb appearance. There were multiple regular filling defects the size of a pea throughout the barium-filled ileum, which could be seen for 48 hours after the barium meal, the appearance being similar to a polyposis of the colon. Operation showed an obstruction in the terminal ileum, the peculiar appearance of the ileum being explained by a tremendous number of grape, apple, and orange seeds which filled the dilated loops of the bowel.

Lipomas of the colon are rather rare and only two have been described in the roentgenologic literature, as far as the authors could find. Two additional cases are described by them. The roentgenologic findings in one case, between the colon descendens and the sigmoid, were that of a carcinoma, partly because there was also a slight invagination. The second lipoma, in the hepatic flexure, was well circumscribed and smooth in the roentgenogram, which was considered as an indication of its benign character. In both cases, surgery and microscopic examination revealed the tumors to be lipomas.

H. W. HEFKE, M.D.

Malignant Testicular Tumors. Louis Bollag. Schweiz. med. Wchnschr., April 30, 1932, LXII, 419-424.

The author discusses three cases of malignant testicular tumor and reviews some of the literature. The relatively frequent development of malignancy in undescended testicles is discussed. There is also

a close association between injury and the development of malignant changes. The recent work of Zondek on the hormonology of these tumors is of interest. Usually prolan A can be detected in the urine of these patients; prolan B is more rarely found. Zondek feels that the presence of a positive Aschheim-Zondek reaction is an index of the general body resistance; however, it may be absent in 40 per cent of cases. The author stresses the beneficial and often curative effects of roentgentherapy.

H. C. OCHSNER, M.D.

Myomas and Ovarian Tumors in the Roentgenogram. Günter K. F. Schultze. Röntgenpraxis, October, 1932, IV, 849-855.

Roentgenologic examination is certainly not indicated for the greater number of gynecological cases; in only a few exceptional ones is it indicated. A flat film is of value mainly in the case of calcified myomas and dermoids. A pneumoperitoneum or even the introduction of lipiodol in the peritoneal cavity is of little, if any, value. Demonstration of the uterus and tubes by means of injected lipiodol is an indirect means; changes in position of these organs gives an idea of the type of tumor present. Inflammatory tumors of the adnexa can be correctly diagnosed in over 90 per cent of the cases examined. The technic has to be most carefully followed. For the diagnosis of carcinomas of the uterus this method is not suitable. Clinically the diagnosis between myomas and ovarian tumors is occasionally impossible. In 128 such cases, in which the diagnosis was proven by operation, hysterosalpingography made possible a correct diagnosis in 84 per cent of the myoma cases, and 69 per cent in the ovarian tumor group. The roentgen signs of myomas are changes in the contour of the uterine cavity, increase in its capacity, and filling defects. Fluoroscopic observation during the injection of the lipiodol is essential in order that one may not miss temporary filling defects. The tubes are often not shown.

These cases were mostly clinically doubtful and not diagnosable. For the demonstration of ovarian tumors, filling of the tubes is necessary as displacement of them and the uterus are the main symptoms. A film taken 24 hours after the injection of the contrast material is often of help; the lipiodol spreads over the surface of the tumor and can thus be directly seen.

H. W. HEFKE, M.D.

POSITION WANTED—By registered x-ray technician and registered nurse. Graduate Johns Hopkins x-ray. Experienced x-ray therapy, radium, and all forms physiotherapy. Member Physiotherapy Association of America and American Society of Radiographers. Post-graduate clinical and pathological work, gas and ether anesthesia. Excellent references. Address G. A. M., care RADIOLOGY.

